03.05-04/01/92-00590

# FINAL

# WORK PLAN

# REMEDIAL INVESTIGATION/FEASIBILITY STUDY FOR CAMP ALLEN LANDFILL (AREAS A AND B) NORFOLK NAVAL BASE, NORFOLK, VIRGINIA

**CONTRACT TASK ORDER 0084**

*Prepared for:*

**NAVAL FACILITIES ENGINEERING COMMAND ATLANTIC DIVISION**
*Norfolk, Virginia*

*Under:*

**Contract N62470-89-D-4814**

*Prepared by:*

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*Coraopolis, Pennsylvania*

**APRIL 23, 1992**

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# 1.0 INTRODUCTION

This document presents the Final Work Plan, for Contract Task Order-0084, Remedial Investigation/Feasibility Study (RI/FS) for the Camp Allen Landfill Site (Areas A and B), Naval Base, Norfolk, Virginia. Baker Environmental, Inc. (Baker) is the prime contractor for the Comprehensive Long-Term Environmental Action Navy Program (Navy CLEAN) under which this CTO is being performed. Figure 1-1 presents a Base Location Map.

This Plan has been prepared to document the scope and objectives of the RI/FS activities. It serves as a tool for establishing site history, assigning responsibilities and identifying the proposed project schedule and investigation activities.

## 1.1 Previous Investigations

Previous investigations of hazardous waste sites at the Naval Base, Norfolk, Virginia have been conducted under an Initial Assessment Study, Confirmation Study, Site Suitability Assessment Study, and an Interim Report of the Installation Restoration (IR) Program.

In April 1982, an Initial Assessment Study (IAS) was conducted at the Sewell's Point Naval Complex, Norfolk Naval Base, Norfolk, Virginia. The IAS identified 18 sites of concern with regard to potential contamination. The Camp Allen Landfill (Areas A and B) were included as potential areas of concern. Figure 1-2 presents a Site Location Map.

In 1983, a Site Suitability Assessment for a proposed Brig expansion project was conducted by Malcolm Pernie, Inc. A geophysical survey was performed at that time to determine the presence of buried metal objects beneath Area A. Additionally, groundwater monitoring wells and soil borings were installed in the vicinity of the Brig and gas monitoring stations were located to measure potential methane releases during construction activities.

CH2M Hill, Inc., conducted an Interim Remedial Investigation at the site (Area A and Area B) in 1990-1991. This investigation included residential well sampling, surface water and sediment sampling, monitoring well installation and groundwater sampling. Additionally, in-situ hydraulic conductivity tests were conducted in selected wells.

As a result of the Superfund Amendments and Reauthorization Act of October 1988 (SARA), the Navy has changed its program to follow rules, regulation, guidelines, and criteria

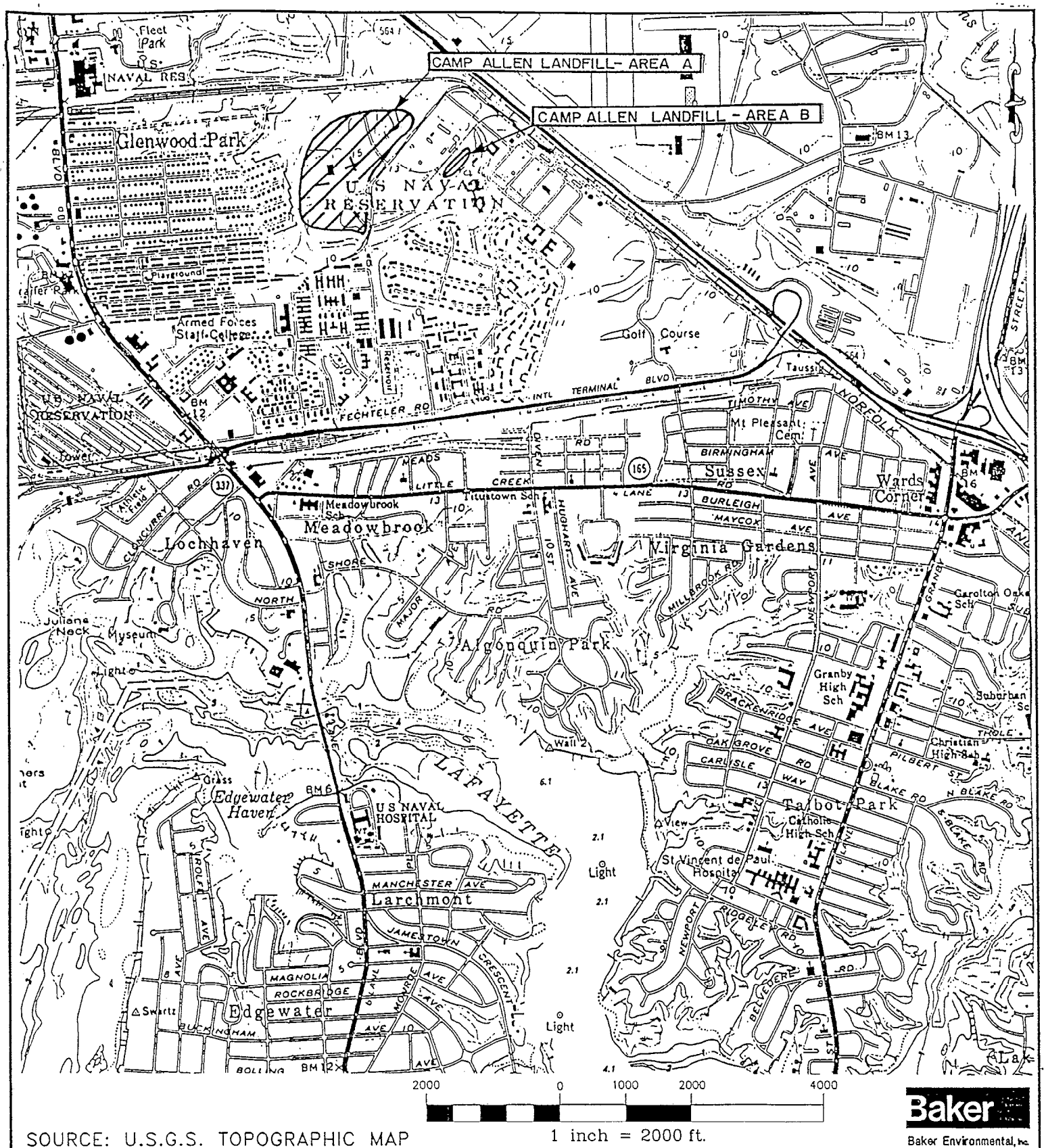
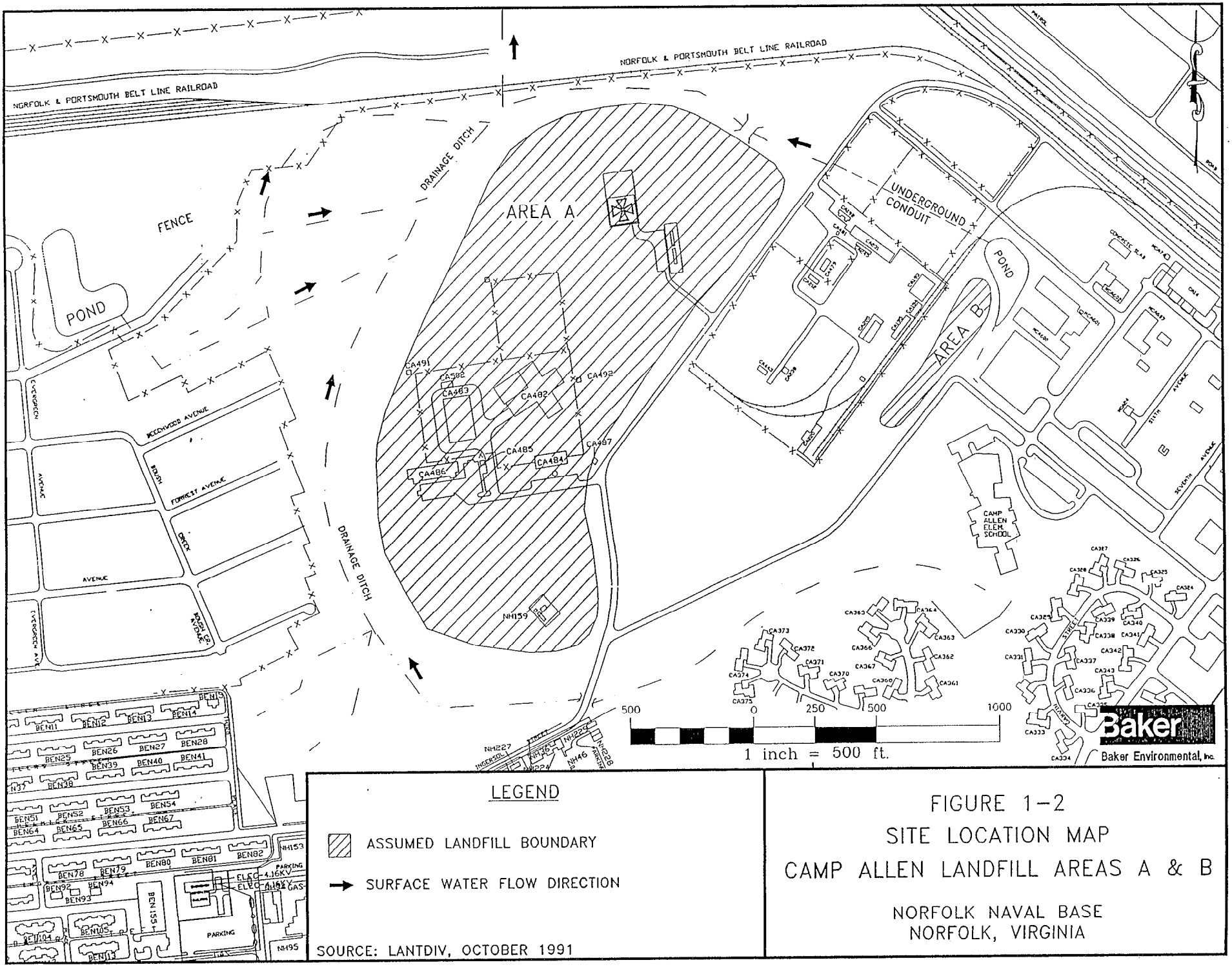



FIGURE 1-1
BASE LOCATION MAP
CAMP ALLEN LANDFILL
AREAS A and B
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA




LEGEND

ASSUMED LANDFILL BOUNDARY

SURFACE WATER FLOW DIRECTION

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 1-2
SITE LOCATION MAP
CAMP ALLEN LANDFILL AREAS A & B

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

established by the Environmental Protection Agency (EPA) for the Superfund Program. Included will be a Technical Review Committee (TRC) meeting composed of representatives from EPA, State and local governments, and the local community.

## 1.2 Description of the Current Study

The current study at the Camp Allen Landfill Site (Areas A and B) is intended to characterize environmental impacts resulting from past activities in these areas. The objectives of the RI/FS are to:

- Determine the nature and extent of contamination at Areas A and B
- Identify possible migration pathways and resulting impacts on environmental and human populations
- Assess risk to human health and the environment
- Obtain data for the development of remedial action alternatives
- Evaluate the proposed remedial alternatives on the basis of technical and practical applicability
- Evaluate the alternatives in terms of health, welfare, and environmental impact

## 1.3 Applicable and Relevant and Appropriate Requirements (ARARs)

SARA Section 121(d) requires the attainment (or justification of a waiver) of Federal and State Applicable or Relevant and Appropriate Requirements (ARARs) upon completion of a remedial action. State ARARs are to be met when the requirements promulgated are more stringent than Federal laws, and identified by the State. The 1990 National Contingency Plan (NCP) requires compliance with ARARs during remedial actions and at completion of the remediation, as well as compels attainment of ARARs during removal action whenever practicable.

Applicable requirements are defined as those "... cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations

promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site" (USEPA, 1988). Relevant and Appropriate Requirements are similarly defined; however, these standards are not applicable to a site (i.e., do not satisfy all the jurisdictional prerequisites of a requirement). Relevant and Appropriate Requirements "... address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site" (USEPA, 1988). ARARs must be attained for hazardous substances remaining on site at the completion of a remedial action. The determination of which requirements are appropriate and relevant is flexible. EPA and the State may look to the type of remedial actions contemplated, the hazardous substances present, the waste characteristics of the site, and other pertinent site-specific factors. A requirement must both be relevant and appropriate to the specific site to be an ARAR, but it is possible for only part of a requirement to be considered relevant and appropriate.

ARARs are identified on a site-specific basis from three types of ARARs: chemical, location, and action-specific. Chemical-specific ARARs are usually health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values and methodologies (i.e., promulgated standards and risk assessments) establish acceptable concentrations of a chemical contaminant that can be found in the environment. Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because the specific locations are of environmental importance (i.e., wetlands, floodplains, wilderness areas). Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy (i.e., capping, excavation).

Occasionally, ARARs are not sufficient to protect public health or the environment. When this occurs, non-promulgated standards, criteria, guidance and advisories must be evaluated along with the chosen ARARs to help provide protective target cleanup levels. These types of non-promulgated standards are referred to as To Be Considered (TBCs) and are not legally binding.

The following is a list of the potential Federal ARARs which may be applied to the two Areas (A and B) at Camp Allen Landfill. The State ARARs will be identified as the project progresses.

### 1.3.1 Chemical-Specific ARARs

- National Primary and Secondary Drinking Water Regulations (Safe Drinking Water Act)
- Federal Ambient Water Quality Criteria (Clean Water Act)
- Water Quality Standards of the Commonwealth of Virginia, VR-680-21-00
- Virginia Air Pollution Control Regulations - VR-120-01 through 120-08
- Other Federal Criteria, Advisories, Guidance and State Standards To Be Considered (i.e., Health Effects Assessments, Reference Doses, Cancer Slope Factors, Health Advisories)
- RCRA MCL's 40 CFR 264 (f) and (s)
- National Ambient Air Quality Standards (Clean Air Act)

### 1.3.2 Location-Specific ARARs

- Endangered Species Act
- Wilderness Act
- Fish and Wildlife Coordination Act
- Wild and Scenic Rivers Act
- Scenic Rivers Act
- Rivers and Harbors Act
- Coastal Zone Management Act
- Clean Water Act, Section 404 (Wetlands)
- 40 Code of Federal Regulations, Part 6, Appendix A (Floodplain Management and Protection of Wetlands)
- National Historic Preservation Act
- Archaeological and Historic Preservation Act
- VA Wetlands Act, Title 62.1

### 1.3.3 Action-Specific ARARs

Action-specific ARARs are not usually identified until the Feasibility Study portion of the investigation when potential remedial technologies are screened. However, potential action-specific ARARs include:

- VA Solid Waste Regulations (VR-672-20-10)
- VA Hazardous Waste Management Regulations (VR-672-10-01)
- Air stripping
- Dike stabilization
- Discharge of treatment system effluent
- Discharge to Publicly Owned Treatment Works
- Dredging
- Discharge or dredge and fill material to waters of the U.S. or ocean waters
- Excavation
- Gas collection
- Groundwater diversion
- Land treatment
- Operation and maintenance
- Placement of wastes in land disposal unit
- Slurry wall
- Surface water control
- Treatment in a unit
- Underground injection of wastes and treated groundwater
- Waste pile

The above list is not yet complete as the investigation has not yet begun. However, this list is sufficient to focus the implementation of the investigative efforts. Additional ARARs will be added as more information becomes available during the field activities.

## 1.4 Document Organization and Presentation

The activities proposed for the Camp Allen Landfill investigation (Areas A and B) are presented in this Work Plan. Section 2 presents information on the Background and Setting of the two areas to be studied. Section 3 discusses the Investigative Tasks to be performed at each area, while Section 4 presents information on the preparation of the Feasibility Study.

Section 5 discusses the project organization and Section 6 presents the project schedule. The references are presented in Section 7.0.

Detailed procedures by which these tasks will be performed and the associated quality objectives are presented as required by applicable Federal regulatory guidelines. Attachment A contains the site specific Health and Safety Plan (HASP). The Sampling and Analysis Plan (SAP) and the Quality Assurance Project Plan (QAPP) will be presented under separate cover.

## 2.0 BACKGROUND AND SETTING

The Camp Allen Landfill Site includes a large area of approximately 45 acres, consisting of Area A (about 43 acres) and Area B (about 2 acres). Figure 1-2 presents a Site Location Map.

Operations at the Camp Allen Landfill (Area A) were conducted from the early 1940's until about 1974 to dispose of a variety of materials. It is estimated that approximately 40,000 pounds of metal plating sludges, 60,000 pounds of mechanical parts cleaning sludges, and 400,000 pounds of paint stripping residues were disposed. Other materials disposed of at the site include incineration ash, fly and bottom ash from the Navy power plant, overage chemicals, spent chlorinated organic solvents, acids, caustics, paints, paint thinners, pesticides, asbestos, scrap metal and construction and demolition debris.

In 1971, a fire in a salvage yard located between Landfill Areas A and B occurred where waste lubricating oils, organic solvents, paints, paint thinners, acids, caustics and pesticides were stored. It was reported that the burned material, smoldering residue from the fire and residual waste, which was not burned, were buried just east of the salvage yard in Area B. Many of these wastes were reportedly drummed or otherwise containerized. The trenches used for landfilling in Area B were reportedly about 150 feet long, six to eight feet deep and 10 feet wide.

At present, the majority of Area A and all of Area B is capped with a grass cover to minimize surface erosion. Area A incorporates the Navy Brig facility in addition to a heliport built over a portion of the landfill. Both areas are adjacent to tidal drainage ditches which convey surface water runoff to Willoughby Bay via the developed channel of Boush Creek.

The IAS identified a high potential for migration of contaminants from the landfill via the (surficial aquifer) to off-site areas via surface water drainage ditches which also accommodate shallow groundwater discharge. Migration of contaminants to the Yorktown Aquifer also was suggested since no evidence of a continuous aquitard (layer of low permeability soils which retard vertical groundwater flow) was found underlying the area. A Confirmation Study was recommended because of the potential for contaminant migration.

Malcolm Pirnie, Inc., conducted two separate investigations related to the Camp Allen Landfill Area between 1983 and 1987. The investigations included a Confirmation Study

(begun in 1983 and completed in 1987) and a Site suitability Assessment (SSA) for a proposed Brig facility expansion at the site (begun in 1983 and completed in 1984).

Seven groundwater monitoring wells were installed prior to the Confirmation Study. Analytical results from the earlier study indicated occasional violations of State Water Control Board (SWCB) groundwater standards for chromium, zinc, silver, lead and phenols. These wells were constructed of galvanized steel and were not appropriate for additional sampling events required as part of the Confirmation Study.

Six shallow (25-feet deep) and one deep (approximately 90 feet deep) groundwater monitoring wells were installed as part of the Confirmation Study. The shallow monitoring wells (GW-1 through GW-6) were installed near the Camp Allen Landfill. Monitoring Wells (GW-1, GW-2 and GW-3) are located in Area A. Monitoring Wells (GW-4, GW-5 and GW-6) are situated in Area B. The deep monitoring well was installed approximately one mile northwest of the site. Additionally, 11 shallow monitoring wells were installed in the southern portion of Area A as part of the SSA.

Groundwater and surface water were sampled in four separate sampling events conducted during the Confirmation Study (December 1983, August 1984, April 1986, and June 1986). The evaluation of organic compounds analyzed indicated that monitoring wells GW-4 and B-20W contain concentrations of several organic compounds (vinyl chloride, methylene chloride, trichlorofluoromethane, 1,1-DCA, Trans-1,2-DCE, 1,2-DCA, 1,1,1-TCA, TCE, Benzene, Toluene, Ethylbenzene) which greatly exceeded the referenced criteria (EPA Water Quality Criteria Documents, November, 1980, EPA Maximum Contaminant Level Goals (MCLG's, November, 1985, and State Water Control Board Water Quality Standards and Criteria, November, 1980). While the contaminant concentrations increased slightly from the first to second sampling event, concentrations appeared to decrease at both well locations in subsequent sampling events during the Confirmation Study.

Inorganic constituents at Area A of Camp Allen Landfill indicate elevated concentrations of total cadmium, chromium, lead and zinc in many wells and surface water locations.

In the fall and winter of 1990-1991 CH2M Hill conducted a Remedial Investigation (RI) at the Camp Allen Landfill. Investigation activities included:

- A soil gas survey in the vicinity of Area B

- The installation of nine shallow (25-feet deep) monitoring wells and six deep (60-feet depth) monitoring wells at Area A

- The installation of eight shallow (25-feet deep) monitoring wells and three deep (60-feet depth) monitoring wells at Area B.

- Groundwater was sampled from both new and selected existing wells.

- Surface water and sediment samples were collected and analyzed from adjacent drainage ditches at Area A and the pond at Area B.

- In-situ conductivity tests were conducted in ten wells at Area A and eight wells at Area B

- Numerous residential wells (shallow - $<50$ feet deep) in Glenwood Park were sampled for volatile organic compounds (VOCs)

The results of the investigation conducted at Area A indicated that contamination from the landfill had not migrated within the shallow aquifer except at low concentrations in the northern portions of the site. Some organic solvent compounds were detected in the deep wells just west of Area A which are screened within the Yorktown Aquifer. Metals were present in the sediments in the drainage channel located just north of Area A.

The results of the investigation conducted at Area B indicated that the contamination has migrated within the shallow aquifer beyond the boundary of the disposal area. VOCs (vinyl chloride and 1,2-dichloroethene) were present in shallow monitoring wells downgradient of the site. VOC contamination also was present in all three deep wells screened in the Yorktown Aquifer. Additionally, surface water and sediment collected at the adjacent pond were contaminated with low concentrations of VOCs.

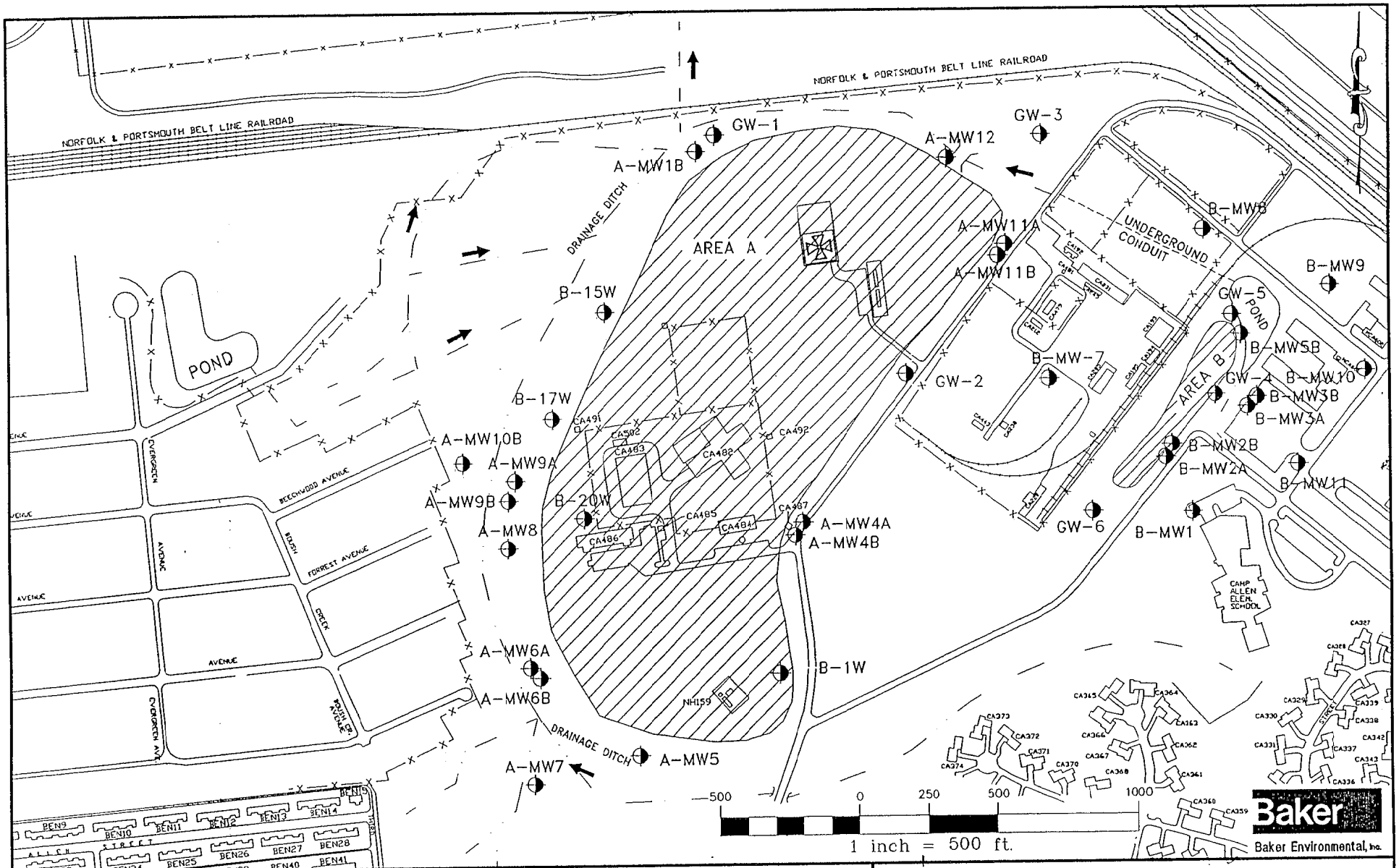
Table 2-1 contains a listing of existing monitoring wells at the Camp Allen Landfill Site. This table is organized such that existing shallow monitoring wells and deep monitoring wells that have been sampled during both the IAS and subsequent RI are broken down into the areas (Area A and Area B) in which they are located. Existing monitoring wells for Area A and Area B are shown on Figure 2-1. Surface water and sediment sample locations for RI activities at Area A and Area B are presented on Figure 2-2.

## TABLE 2-1

## EXISTING MONITORING WELLS
## CAMP ALLEN LANDFILL

| | Area A | Area B |
|---|---|---|
| Deep[1] | A-MW1B | B-MW2B |
| | A-MW4B | B-MW3B |
| | A-MW6B | B-MW5B |
| | A-MW9B | |
| | A-MW10B | |
| | A-MW11B | |
| Shallow[2] | GW-1 | GW-4 |
| | GW-2 | GW-5 |
| | GW-3 | BW-6 |
| | B-1W | |
| | B-15W | |
| | B-17W | |
| | B-20W | |
| Shallow[1] | A-MW4A | B-MW1 |
| | A-MW5 | B-MW2A |
| | A-MW6A | B-MW3A |
| | A-MW7 | B-MW7 |
| | A-MW8 | B-MW8 |
| | A-MW9A | B-MW9 |
| | A-MW11A | B-MW10 |
| | A-MW12 | B-MW11 |

(1) CH2M Hill wells.
(2) Malcolm Pirnie wells.



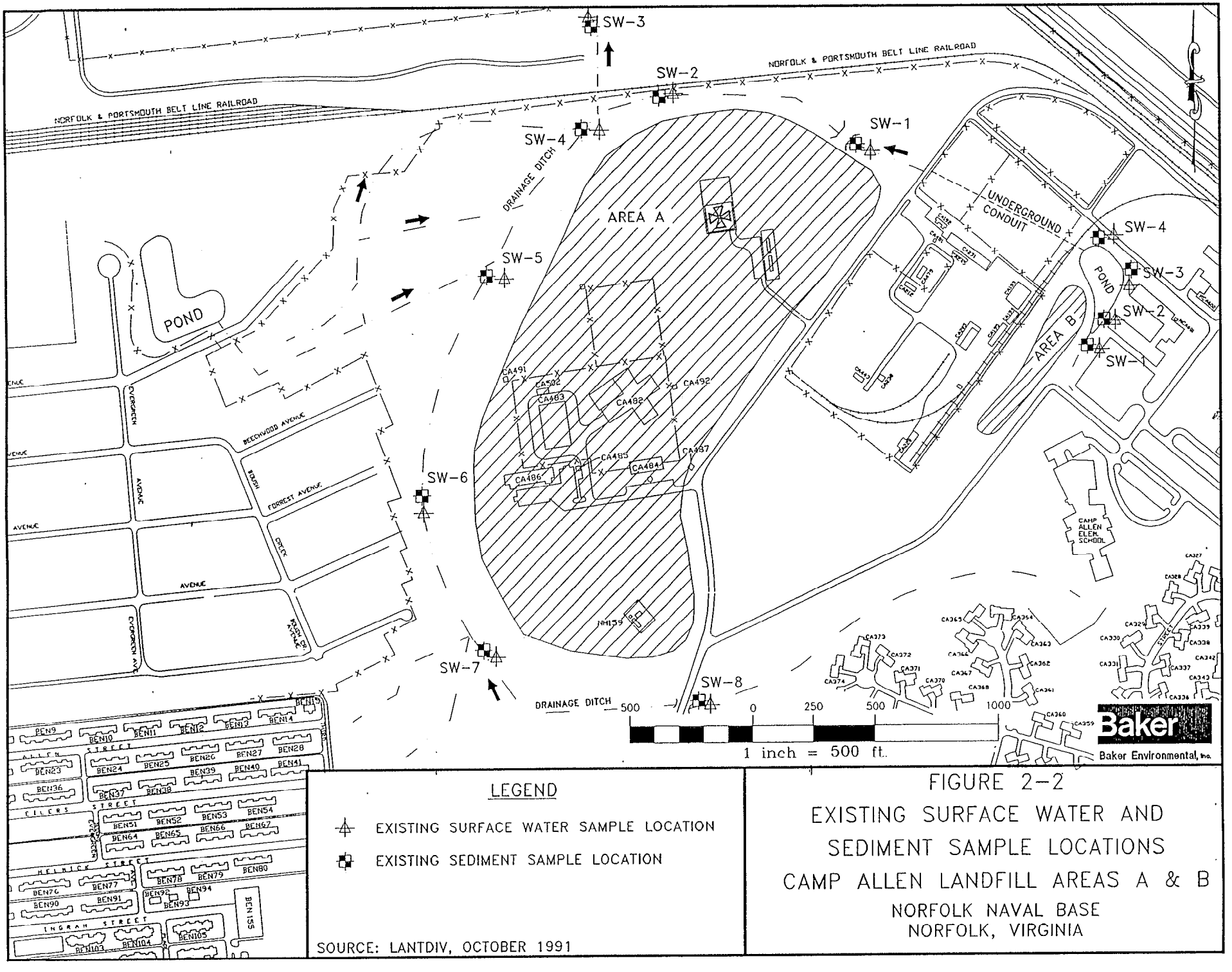

LEGEND

⊕ EXISTING MONITORING WELL LOCATION

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 2-1
EXISTING MONITORING WELLS
CAMP ALLEN LANDFILL AREAS A & B

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA




LEGEND

EXISTING SURFACE WATER SAMPLE LOCATION

EXISTING SEDIMENT SAMPLE LOCATION

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 2-2

EXISTING SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS

CAMP ALLEN LANDFILL AREAS A & B

NORFOLK NAVAL BASE

NORFOLK, VIRGINIA

## 3.0 INVESTIGATIVE TASKS

The site investigation discussed below presents an overview of the various field activities to be conducted at the Camp Allen Landfill Site (Areas A and B). The specific details of these activities are provided in the Sampling and Analysis Plan (SAP) and Quality Assurance Project Plan (QAPP) to be submitted under separate cover. The field investigations proposed herein reflect the criteria to meet the RI/FS objectives identified in Section 1.2 of this Work Plan.

Prior to field activities, procurement of services such as land surveying, drilling, Geoprobe, laboratory analysis, and data validation will be performed in accordance with the Navy CLEAN Contract Procurement Manual.

### 3.1 Field Activities - Area A

Field activities will include a geophysical survey, residential well sampling, surface water/sediment sampling, drilling and installation of groundwater monitoring wells with associated groundwater sampling, advancement of subsurface soil borings with associated subsurface soil sampling, ambient air sampling, slug tests, an aquifer test and land surveying.

#### 3.1.1 Geophysical Survey

At the outset of the investigation for this site, a geophysical survey will be conducted in order to assist in defining a drainage channel thought to be present below the landfill. Various techniques will be utilized including electromagnetic, gamma and resistivity profiling.

In order to better define the location of a channel previously situated in the vicinity of Area A, the following geophysical survey tasks will be conducted:

- Three transects each of EM 31 and EM 34 data runs
- Resistivity sounding (five sectors totaling not more than 2,000 L.F.)
- Six borehole gamma logs

In general, EM profiling and resistivity soundings will be performed at locations surrounding Area A in order to determine characteristics of the remnant drainage channel thought to be present below the landfill. EM profiling and resistivity sounding locations will complement

one another in order to correlate and confirm surface geophysical results. Additionally, gamma logging will be performed at six existing well locations (A-M1B, A-MW4B, A-MW6B, A-MW9B, A-MW11B, and B-1W). Five deep well locations are selected in order to maximize subsurface characterization. If either of the 110-foot deep wells (A-MW1C and/or A-MW9C) are completed at the time of gamma logging, these wells will be used during the geophysical investigation instead of AMW1B and/or AMW9B. Proposed geophysical investigation locations are shown on Figure 3-1.

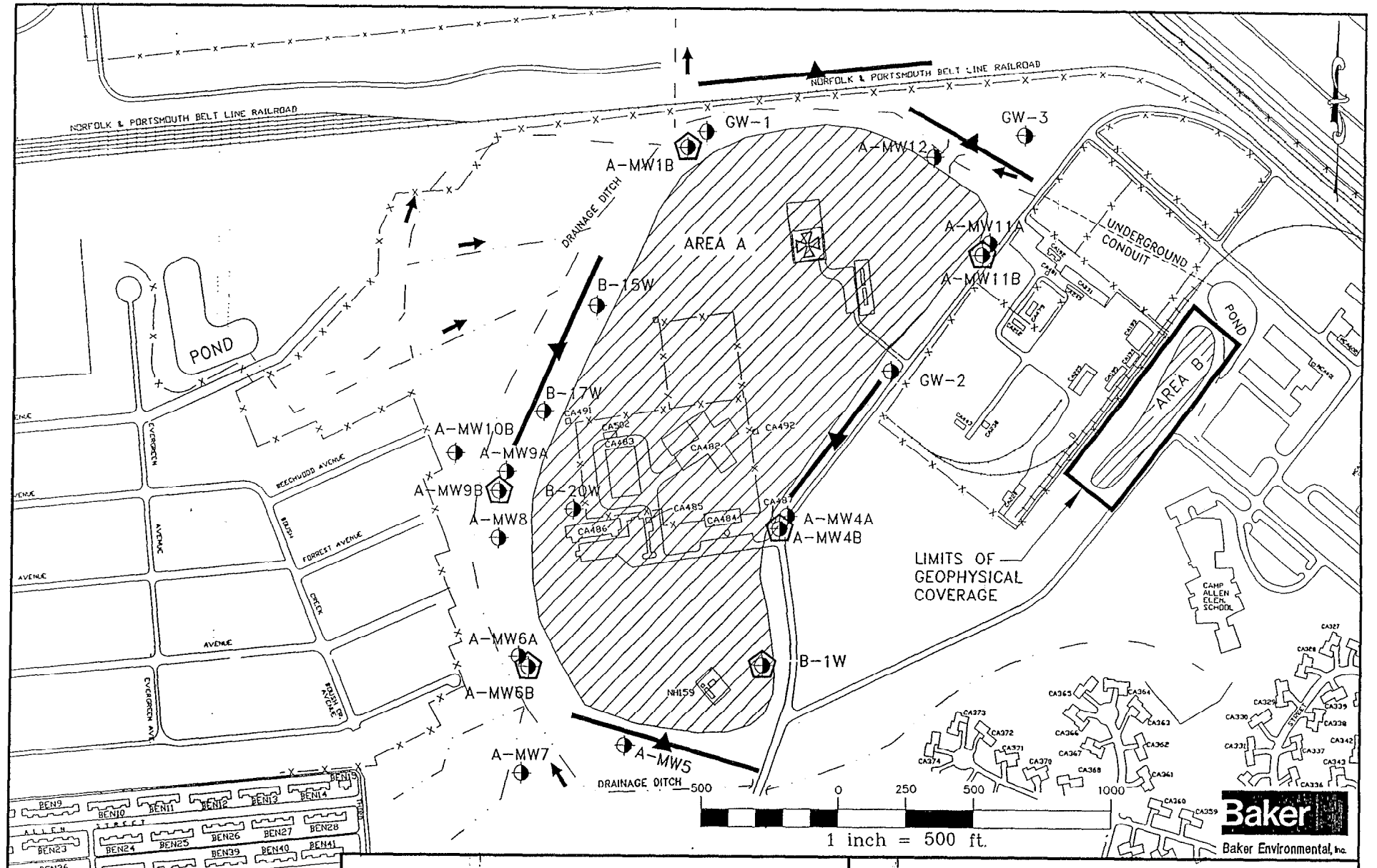
### 3.1.2 Residential Well Sampling

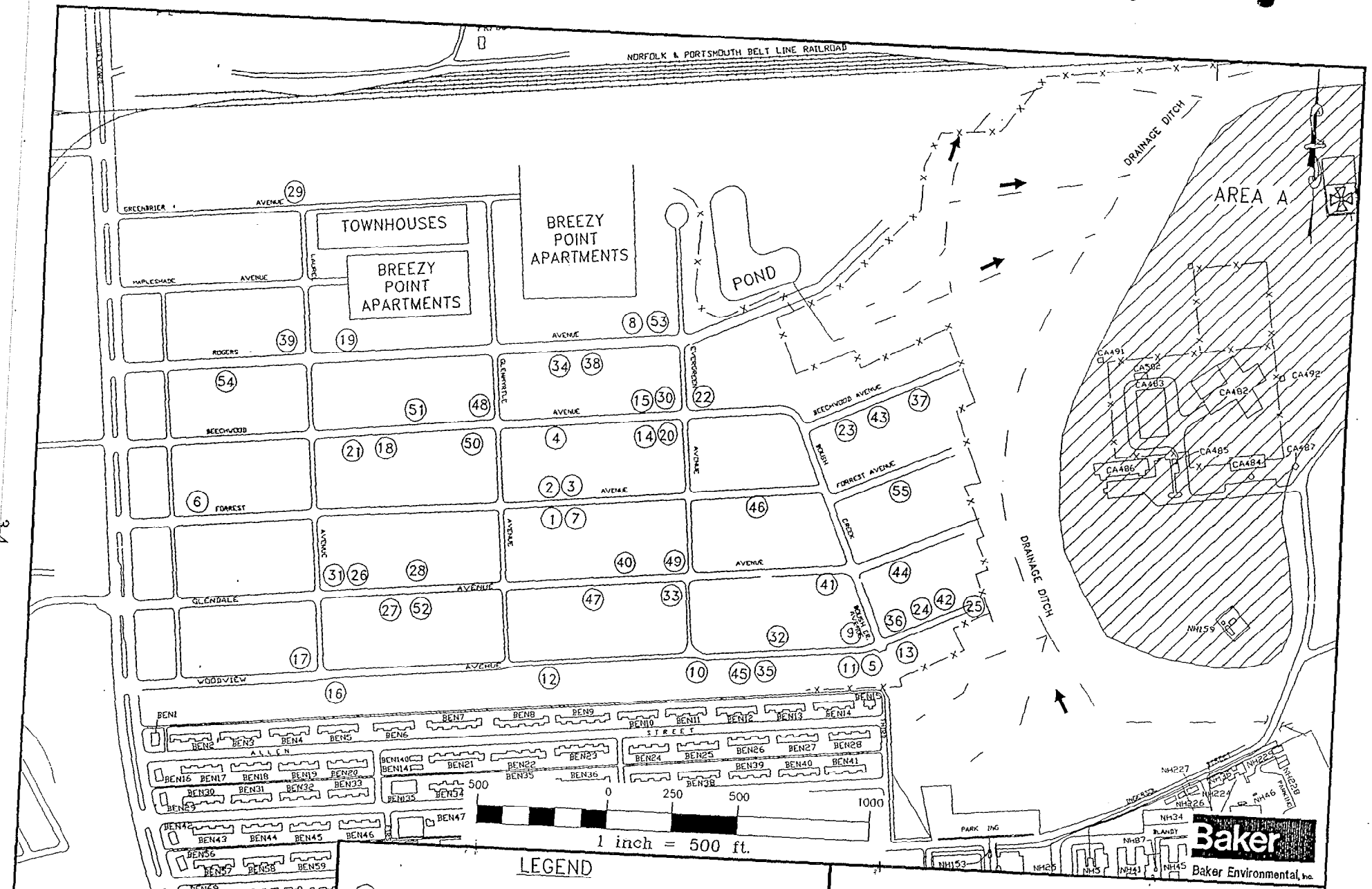
Fifty-five (55) residential wells in the Glenwood Park area located west of the Area A landfill were sampled during the previous investigation (see Figure 3-2). Table 3-1 contains street locations of residential wells shown on Figure 3-2. Approximately five residential wells remain to be sampled. Residential well sampling is anticipated to be conducted prior to mobilizing drilling rigs. Samples from residential wells will be analyzed for Target Compound List volatile organic compounds during this investigation. In accordance with the Scope of Work (SOW), LANTDIV/Activity personnel will make arrangements with residents in order to initiate sampling activities.

### 3.1.3 Surface Water and Sediment Sampling

Surface water and sediment will be sampled from the drainage channels in the vicinity of Area A. Sediment samples will be collected from 20 locations as presented in Figure 3-3. Samples will be collected from a depth of 0 to 0.5 feet at each location. Additionally, one sediment sample will be collected from a depth of 2 to 2.5 feet at six of the locations and analyzed for selected metals (arsenic, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and vanadium). Surface water samples will be collected from eight locations (Figure 3-1) and will be analyzed for Target Compound List (TCL) and Target Analyte List (TAL) parameters, chloride, sulfate, and alkalinity.

Surface water and sediment sample locations are based on the eight previous locations and analytical results of RI activities. Twelve (12) additional sediment samples have been located to provide detail regarding areal extent of potential sediment contamination (Figure 3-3). Please note that, pending field verification, some proposed sampling locations may be modified to address other potential drainageways.


NORFOLK & PORTSMOUTH BELT LINE RAILROAD
NORFOLK & PORTSMOUTH BELT LINE RAILROAD
GW-1
GW-3
A-MW1B
A-MW12
DRAINAGE DITCH
AREA A
A-MW11A
A-MW11B
UNDERGROUND CONDUIT
B-15W
POND
B-17W
GW-2
AREA B
POND
A-MW10B
A-MW9A
A-MW9B
B-20W
A-MW8
A-MW4A
A-MW4B
LIMITS OF GEOPHYSICAL COVERAGE
CAMP ALLEN ELEM. SCHOOL
A-MW6A
B-1W
A-MW6B
A-MW7
A-MW5
DRAINAGE DITCH
500 0 250 500 1000
1 inch = 500 ft.
Baker
Baker Environmental, Inc.
LEGEND
EXISTING MONITORING WELL LOCATION
EM PROFILE
GAMMA LOGGING LOCATION
RESISTIVITY SOUNDING
SOURCE: LANTDIV, OCTOBER 1991
FIGURE 3-1
PROPOSED GEOPHYSICAL INVESTIGATION
CAMP ALLEN LANDFILL AREAS A & B
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA




LEGEND

(1) RESIDENTIAL WELL

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 3-2
PREVIOUSLY SAMPLED
RESIDENTIAL WELL LOCATIONS
CAMP ALLEN LANDFILL

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

TABLE 3-1

RESIDENTIAL WELL SAMPLING LOCATIONS

| Residential Well Number | Street Address | Comments[1] |
|---|---|---|
| RW-1 | 327 Forrest Avenue | |
| RW-2 | 314 Forrest Avenue | |
| RW-3 | 318 Forrest Avenue | |
| RW-4 | 317 Beechwood Avenue | |
| RW-5 | 425 Woodview Avenue | |
| RW-6 | 126 Forrest Avenue | |
| RW-7 | 333 Forrest Avenue | |
| RW-8 | 332 Rogers Avenue | |
| RW-9 | 434 Woodview Avenue | |
| RW-10 | 401 Woodview Avenue | |
| RW-11 | 421 Woodview Avenue | |
| RW-12 | 311 Woodview Avenue | |
| RW-13 | 503 Woodview Avenue | |
| RW-14 | 331 Beechwood Avenue | |
| RW-15 | 326 Beechwood Avenue | |
| RW-16 | 203 Woodview Avenue | |
| RW-17 | 134 Woodview Avenue | |
| RW-18 | 217 Beechwood Avenue | |
| RW-19 | 204 Rogers Avenue | |
| RW-20 | 337 Beechwood Avenue | |
| RW-21 | 209 Beechwood Avenue | |
| RW-22 | 400 Beechwood Avenue | |
| RW-23 | 505 Beechwood Avenue | |
| RW-24 | 504 Woodview Avenue | |
| RW-25 | 515 Woodview Avenue | |

(1) Pending LANTDIV/Activity coordination/direction, sampling times/locations will be verified. Note: Approximately five residential wells remain to be sampled.

TABLE 3-1 (Continued)

RESIDENTIAL WELL SAMPLING LOCATIONS

| Residential Well Number | Street Address | Comments[1] |
|---|---|---|
| RW-26 | 218-A Glendale Avenue | |
| RW-27 | 223 Glendale Avenue | |
| RW-28 | 228 Glendale Avenue | |
| RW-29 | 136 Greenbrier Avenue | |
| RW-30 | 334 Beechwood Avenue | |
| RW-31 | 212 Glendale Avenue | |
| RW-32 | 420 Woodview Avenue | |
| RW-33 | 343 Glendale Avenue | |
| RW-34 | 313 Rogers Avenue | |
| RW-35 | 411 Woodview Avenue | |
| RW-36 | 500 Woodview Avenue | |
| RW-37 | 533 Beechwood Avenue | |
| RW-38 | 323 Rogers Avenue | |
| RW-39 | 136 Rogers Avenue | |
| RW-40 | 330 Glendale Avenue | |
| RW-41 | 431 Glendale Avenue | |
| RW-42 | 516 Woodview Avenue | |
| RW-43 | 525 Beechwood Avenue | |
| RW-44 | 503 Glendale Avenue | |
| RW-45 | 405 Woodview Avenue | |
| RW-46 | 411 Forrest Avenue | |
| RW-47 | 325 Glendale Avenue | |
| RW-48 | 242 Beechwood Avenue | |
| RW-49 | 342 Glendale Avenue | |
| RW-50 | 237 Beechwood Avenue | |

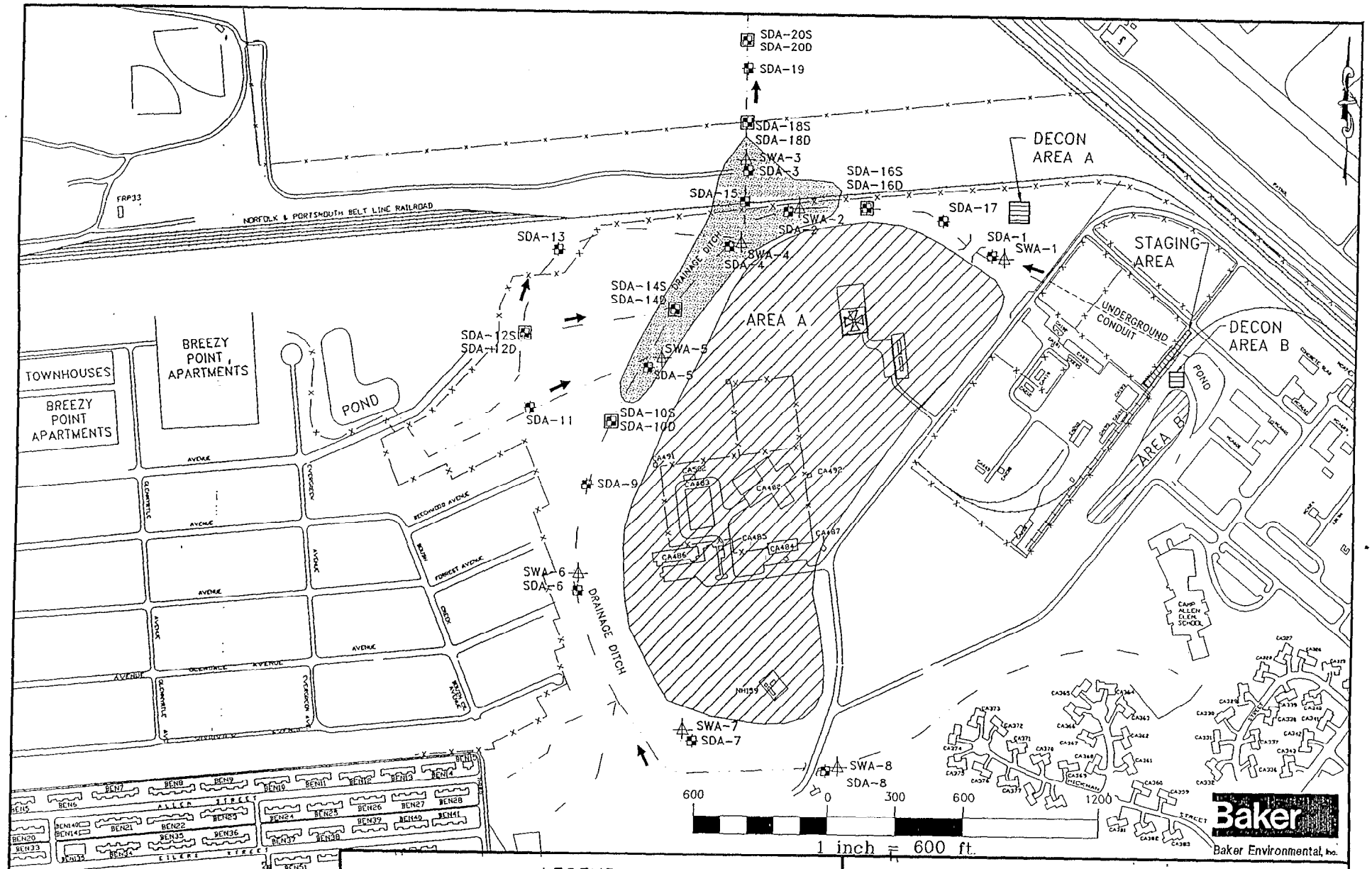
(1) Pending LANTDIV/Activity coordination/direction, sampling times/locations will be verified. Note: Approximately five residential wells remain to be sampled.

TABLE 3-1 (Continued)

RESIDENTIAL WELL SAMPLING LOCATIONS

| Residential Well Number | Street Address | Comments(1) |
|---|---|---|
| RW-51 | 222 Beechwood Avenue | |
| RW-52 | 215 Glendale Avenue | |
| RW-53 | 340 Rogers Avenue | |
| RW-54 | 131 Rogers Avenue | |
| RW-55 | 505 Forrest Avenue | |

(1) Pending LANTDIV/Activity coordination/direction, sampling times/locations will be verified. Note: Approximately five residential wells remain to be sampled.

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- PROPOSED SEDIMENT SAMPLE LOCATION DEPTH 0 – 0.5 ft.
- PROPOSED SURFACE WATER SAMPLE LOCATION
- PROPOSED SEDIMENT SAMPLE LOCATION DEPTH 0 – 0.5 ft. AND 2.0 ft. – 2.5 ft.
- AREA OF ELEVATED METALS CONCENTRATIONS (SEDIMENTS)

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 3-3
PROPOSED SURFACE WATER AND SEDIMENT SAMPLE LOCATIONS
CAMP ALLEN LANDFILL – AREA A
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

### 3.1.4 Monitoring Well Installation

Subsequent to the geophysical survey and residential well sampling, a series of monitoring wells will be drilled and installed to determine the extent of groundwater contamination at Area A as presented in Figure 3-4. The wells will be installed as follows:

- Two 110-foot deep wells will be installed near A-MW9B and A-MW1B. These two wells will be constructed as Type III (refer to Section 5.0 in the Sampling and Analysis Plan) monitoring wells and will be set at 110 feet, but drilling is anticipated to reach about 150 feet depth to define the bottom elevation of the Yorktown aquifer. These two wells will be installed first. If contaminants exist at levels deeper than 65 feet, total depth of the seven 65-foot deep wells to be drilled downgradient from the landfill will be evaluated and modified, if necessary.

- Seven 65-foot deep monitoring wells will be installed after receiving groundwater analytical results from the 110-foot deep wells. Two wells will be installed on-site near monitoring well locations A-MW8 and B-15W. The well at A-MW-8 will be 4-inches in diameter to facilitate conducting an aquifer test. Five wells will be installed downgradient of the landfill on the north/northwestern side of the drainage channel. One or two of these wells may be located off Naval Base, Norfolk property.

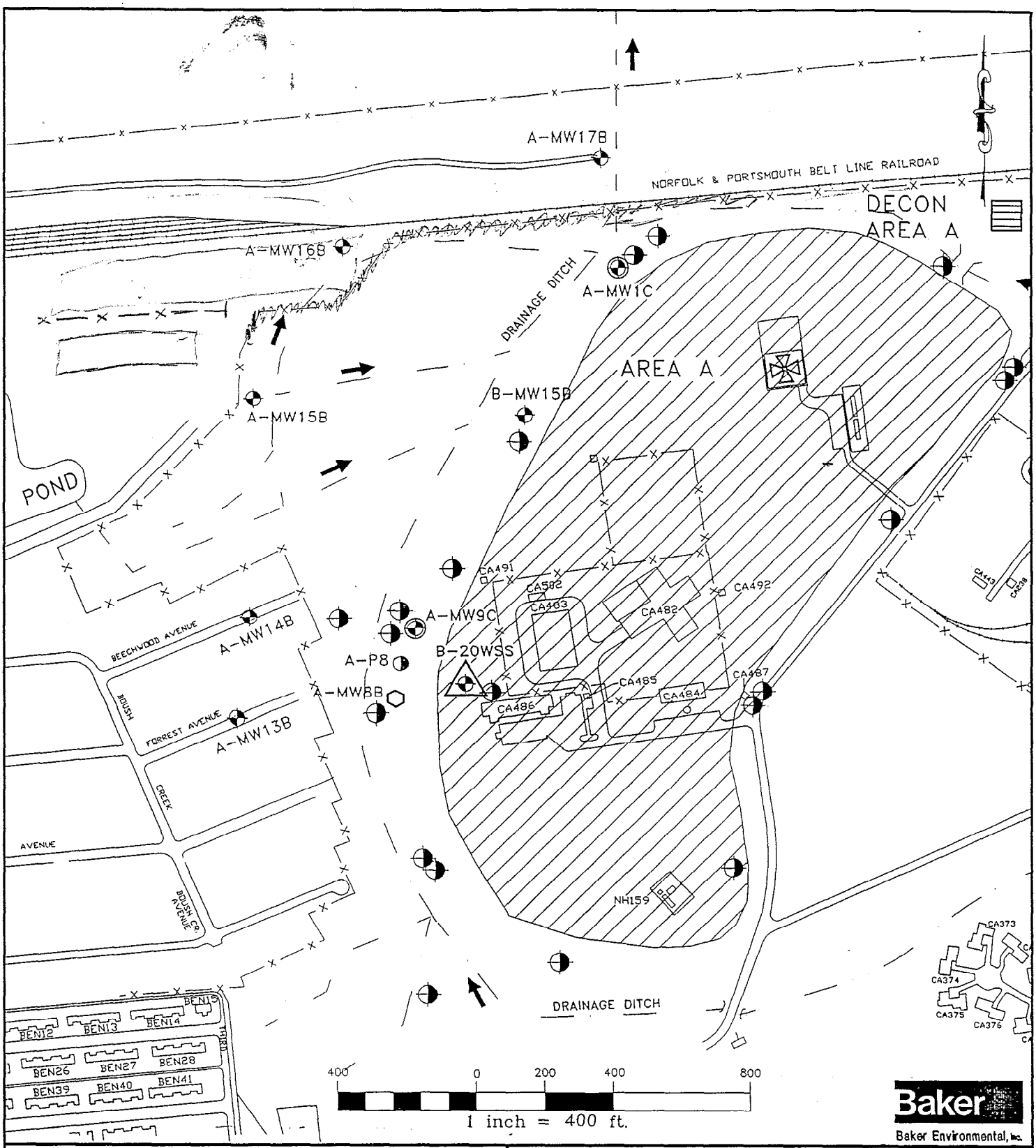
- One 65-foot deep piezometer will be installed near A-MW-8 for the aquifer test.

Proposed monitoring well locations are based on analytical results of previous investigations and at areas in need of further characterization. Wells located in the residential area will determine the presence or absence of potential contamination in the Yorktown aquifer and may provide valuable groundwater level response to proposed aquifer testing.

### 3.1.5 Characterization of Contamination from B-20W Source

The extent of contamination at monitoring well B-20W will be characterized as follows:

- One stainless-steel monitoring well will be installed adjacent to B-20W to the bottom of the surficial aquifer to evaluate the presence of Dense Nonaqueous Phase Liquids (DNAPLs) at this location. It is assumed drilling will be performed in elevated levels of personal protective equipment (Level C or Level B).




LEGEND

- PROPOSED TYPE III MONITORING WELL LOCATION ( DEPTH 65 ft.)
- PROPOSED TYPE III MONITORING WELL LOCATION ( DEPTH 110 ft.)
- PROPOSED TYPE III PUMPING WELL LOCATION (DEPTH 65 ft.)
- PROPOSED PIEZOMETER LOCATION (DEPTH 65 ft.)
- EXISTING MONITORING WELL LOCATION (DEPTH 30ft.)
- PROPOSED STAINLESS STEEL (TYPE II) WELL LOCATION (DEPTH 30ft.)

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 3-4
PROPOSED MONITORING WELL LOCATIONS
CAMP ALLEN LANDFILL – AREA A

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

- Eight soil borings will be drilled to a depth of 20 feet near this area in order to evaluate the extent of the contamination source in the soil (Level C or Level B) [See Figure 3-5].

- Soil samples from the borings will be screened with an HNu photoionization detector and one soil sample from each boring will be submitted for analysis of TCL parameters.

### 3.1.6 Geologic Borings

Ten subsurface borings will be drilled in and around the landfill at Area A (see Figure 3-5) to better define the distribution of the clay layer beneath the surficial aquifer. Level B or Level C protection will be used during drilling operations. The clay layer is assumed to begin at a depth of approximately 30 feet and extend to a depth of about 60 feet. The borings will be advanced to an approximate depth of 40 feet (no more than two to four feet into the clay layer). Boring locations are based on boring logs from previous investigations and may be adjusted following preliminary geophysical investigation results.

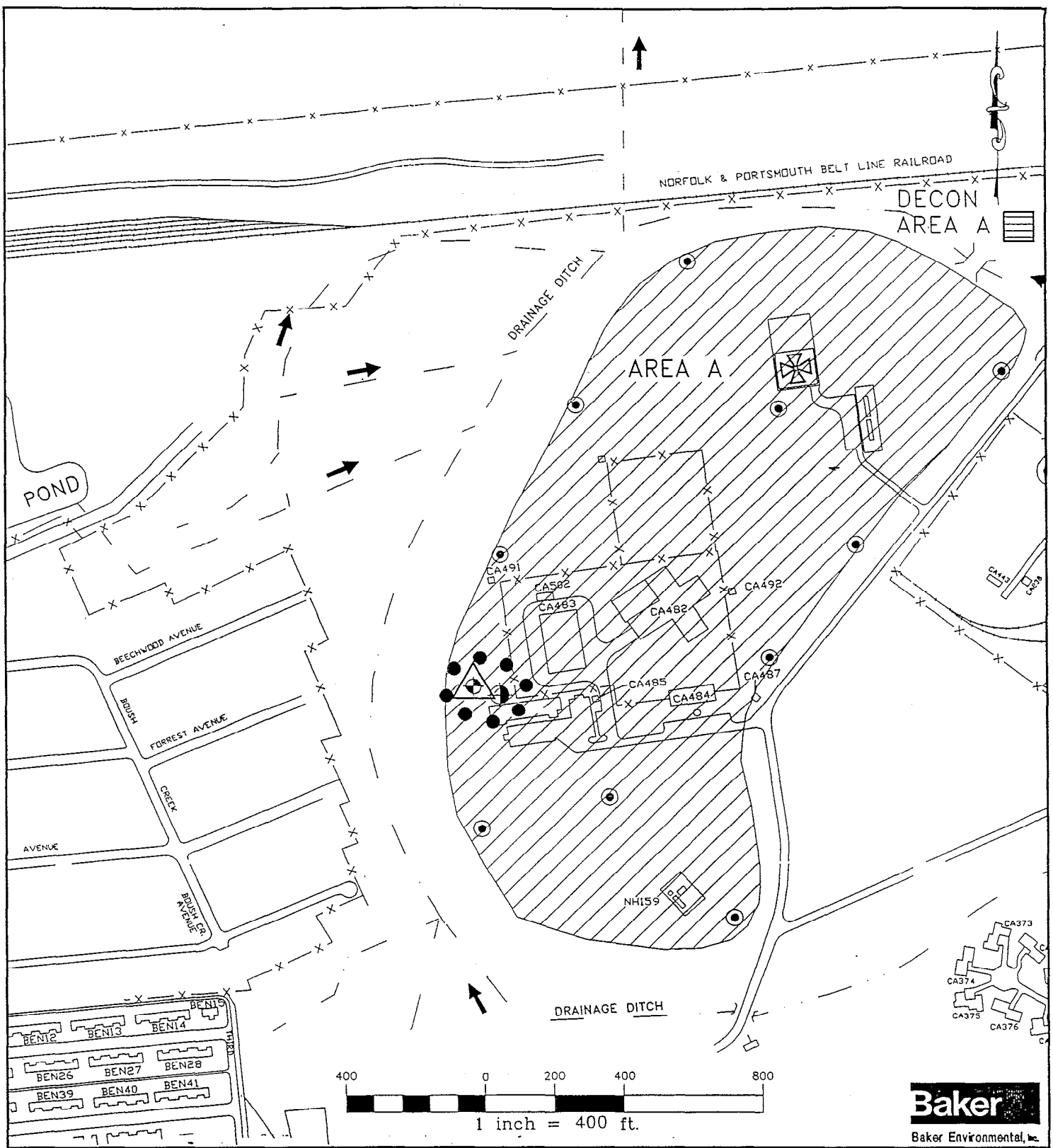
One sample of clay will be collected from five borings (selected in the field) and submitted to a laboratory for physical parameter testing to include:

- Grainsize by sieve and hydrometer (D422)
- Atterberg limits
- Bulk density
- Moisture content (D2216)

### 3.1.7 Groundwater Sampling/Sample Analysis

Three separate groundwater sampling events will be conducted as part of the investigation. The results of the first round will be used to help determine if the extent of the contamination has been defined by the newly installed wells.

Round 1 - Subsequent to well development of each of the seven newly installed 65-foot deep wells, groundwater will be collected and analyzed for chlorinated volatile organic compounds (VOCs) by EPA Method 601. This method utilizes a gas chromatograph (GC) to screen for halogenated volatile organic compounds. Additionally, the two 110-foot deep monitoring wells will be sampled and analyzed for EPA Method 624. This method utilizes a gas




LEGEND

- PROPOSED GEOLOGIC BORING (DEPTH 40 ft.)
- PROPOSED SOURCE CHARACTERIZATION BORINGS (DEPTH 20 ft.)
- B-20W
- B-20WSS

SOURCE: LANTDIV, OCTOBER 1991

FIGURE 3-5
PROPOSED TEST BORING LOCATIONS
CAMP ALLEN LANDFILL - AREA A

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

chromatograph/mass spectrometer (GC/MS) which analyzes a wide array of VOCs in water and has the capability of analyzing tentatively identified compounds (TICs).

Wells will be developed and sampled not less than 24 hours after installation per LANTDIV direction. A local laboratory will be used to analyze the samples on a two to three day accelerated turn around basis.

Round 2 - Seventeen (17) shallow wells (includes stainless steel well) and 15 deep wells will be purged, sampled, and submitted to the laboratory to be analyzed for the TCL and TAL compounds, chloride, sulfate, and alkalinity. Contract Laboratory Program protocols (Level D QA/QC) will be used during analysis. Sampling will occur after all wells have been installed and developed.

Round 3 (Optional) - Fifteen deep wells will be purged and sampled no less than three months (90 days) after the second sampling event. These samples will be analyzed for the TCL volatile organic compounds only. It is assumed that the other compounds will not be detected in significant concentrations to require continued monitoring. If significant concentrations of other parameters are detected a modified analysis of groundwater may be required. Contract Laboratory Program protocols (Level D QA/QC) will be used during analysis.

Static water level will be measured in all existing and newly installed wells during each sampling event. Measurements will be obtained from top of casing to determine groundwater elevation. Additionally, measurements will be obtained from staff gauges installed during the previous investigation.

### 3.1.8 Air Sampling at Brig Facility (Optional)

Air sampling activities will be conducted according to an Air Sampling Plan Addendum to be developed by Baker for the Navy. In general, 15 air samples will be collected in the vicinity of the Brig Facility at Area A and will be analyzed for TCL volatile organic compounds.

Six samples will be collected inside the facility at a location nearest to monitoring well B-20W. Five samples will be collected outside the facility in the vicinity of monitoring well B-20W. Additionally, two background samples will be collected from inside the building and two background samples will be collected from outside the building at points farthest from well B-20W. It is anticipated that two eight-hour sampling periods will occur during this activity.

### 3.1.9 Slug Tests

An in-situ hydraulic conductivity test (slug test) will be conducted on eight of the 11 newly installed wells (six 65-foot and two 110-foot deep) at Area A. The 4-inch well, stainless steel and piezometer will not be included in this task.

The hydraulic conductivity tests will be a standard variation of the falling-head or rising-head slug test. In this type of test, a solid slug of known dimensions is introduced below the water table or withdrawn quickly to induce a disturbance in the water column. Monitoring wells with measurable free-product will not be considered for the well-head tests. Water level data will be collected using In-Situ Environmental Data Loggers equipped with pressure transducers. All downhole equipment will be decontaminated using the same procedures as described in Section 2.10.

Data generated from the hydraulic conductivity tests will be analyzed using the Geraghty and Miller aquifer test solver (AQTESOLV) program. This program uses the Bouwer and Rice (1967) method (for unconfined aquifers) for analysis of data. Data obtained from the hydraulic conductivity tests will provide estimates of hydraulic conductivity, transmissivity, and storativity. Estimated values for hydraulic conductivity will be associated with the probable thickness of the shallow saturated layer to approximate a value of transmissivity for the shallow zone.

### 3.1.10 Aquifer Testing

Aquifer characterization tests will be performed to evaluate the hydraulic characteristics of the Yorktown aquifer. Tests will include a step drawdown, a 24-hour drawdown and a 24-hour recovery. The four-inch Type III well (A-MW8B) will be used as the pumping well location and observation wells will be selected from surrounding monitoring wells and the nearby piezometer. Observation locations will be verified in the field. A maximum of eight locations will be observed using pressure transducers. Other locations may be manually monitored using water level indicators.

The step drawdown test will be performed in order to establish the constant flow rate to be used during the 24-hour drawdown test. Based on hydrogeologic information of the area, the maximum flow rate is not anticipated to exceed 5-10 gallons per minute. All discharged

groundwater will be containerized for proper disposal. The drilling subcontractor will supply required tanker trucks for groundwater containment. An estimated 20,000 gallons of groundwater will be generated by aquifer testing.

The drawdown test will be an aquifer test in which a constant discharge rate will be maintained for a 24-hour interval. Water level measurements via pressure transducers and water level indicators will be recorded at prescribed time intervals. Flow rates will be periodically recorded as well.

At the conclusion of the drawdown phase of the testing, the pump will be shut down and water level recovery measurements will be recorded for a period of 24-hours or until water levels have reached ± 10% initial water level elevations.

### 3.1.11 Groundwater Modeling (Optional)

USGS MODFLOW software will be used to simulate groundwater conditions at the site in the unconfined surficial aquifer and in the confined Yorktown aquifer. In general, the models will be used to help evaluate the effectiveness of potential remediation alternatives. The models will be established by defining appropriate groundwater boundary values, field determined aquifer conditions and other identifiable hydrogeologic features. The selection of the boundary surfaces and conditions will be the primary step in conceptualizing and developing models of the subject groundwater systems.

### 3.1.12 Land Surveying

Thirty-two monitoring wells at Area A will be surveyed for vertical control and horizontal control. Additionally, site structures (i.e., staff gauges) will be surveyed as required.

## 3.2 Field Activities - Area B

Field activities at Area B will include a geophysical survey, surface water/sediment/surface soil sampling, an in-situ groundwater (Geoprobe) investigation, installation of groundwater monitoring wells with associated groundwater sampling, advancement of ten soil borings on the landfill with associated subsurface soil sampling, slug tests, and land surveying.

### 3.2.1 Surface Water/Sediment/Soil Sampling

Sediment samples will be collected from six locations at a depth of 0 to 0.5 feet. Additionally, one sediment sample will be obtained from a depth of 2 to 2.5 feet at two of the locations. Therefore, a total of eight sediment samples will be submitted for analysis of parameters from the TCL and TAL. Five locations will correspond to previous sampling locations. One location will be determined in the field.

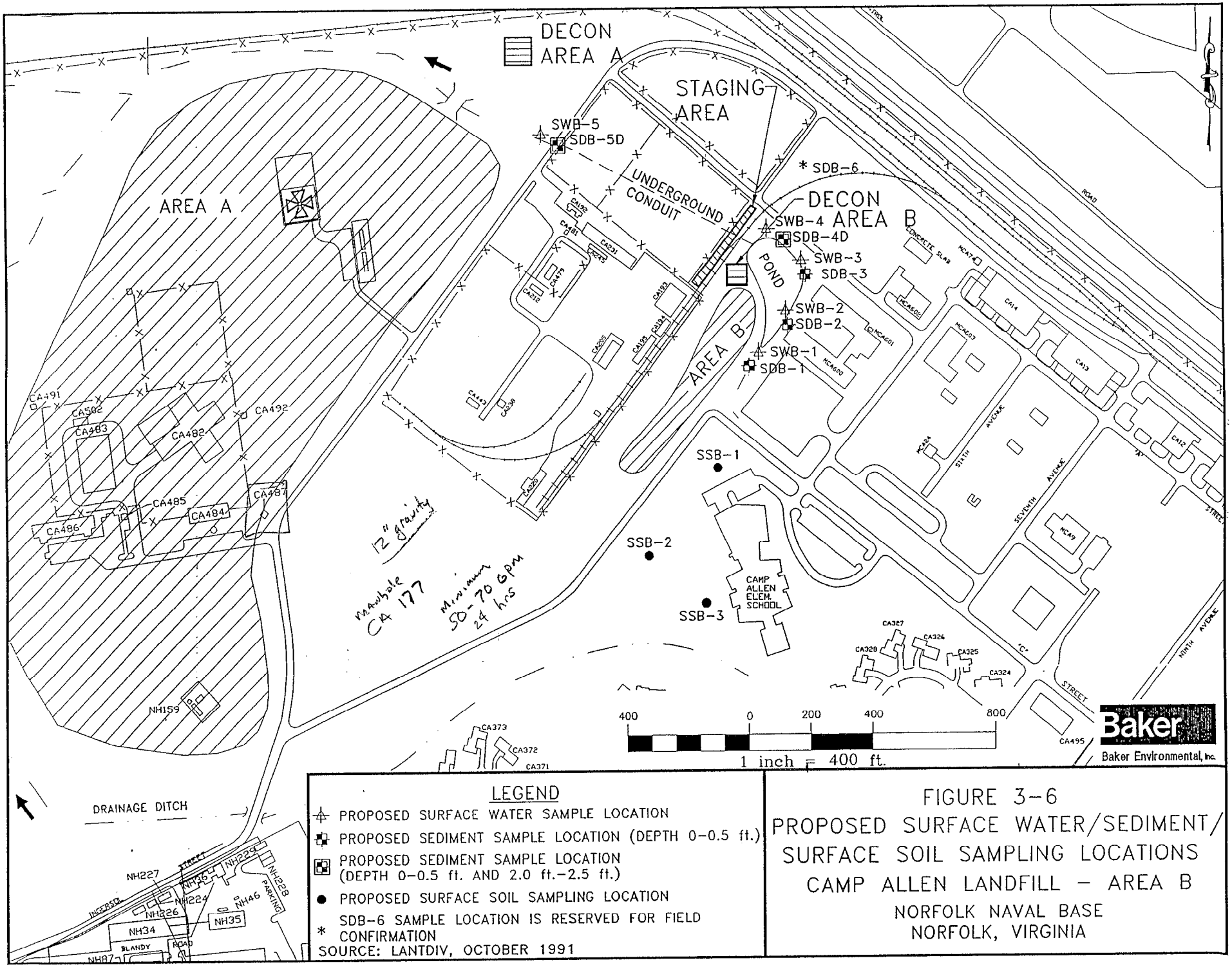
Surface water samples will be obtained from five locations and will be analyzed for TCL and TAL parameters.

Near-surface soil samples will be collected from a depth of about two feet below ground surface in the vicinity of the schoolyard adjacent to Area B. One composite sample will be generated from approximately five soil samples. A total of three composite samples will be submitted to the laboratory for analysis of TAL metals only. All analytical work under this task will be conducted using CLP protocols (Level D QA/QC).

Figure 3-6 presents surface water/sediment sampling locations and surface soil sampling locations at Area B.

### 3.2.2 In-situ Groundwater Sampling (Geoprobe)

Prior to monitoring well installation east of Area B, groundwater samples will be collected from 25 locations (Figure 3-7) by driving a probe to a depth of approximately 15 feet (or to about five feet below the groundwater table as determined in the field). Samples will be screened in the field using a portable Gas Chromatograph (GC). Additionally, samples will be analyzed by a non-NEESA certified local laboratory using EPA Method 601. Based on elevated contaminant concentrations previously detected, groundwater samples will be analyzed for selected VOCs. Subsequent to sampling, the Geoprobe will be removed and the hole will be backfilled with a cement/bentonite grout to the ground surface. Monitoring well locations will be based on groundwater analysis results from the Geoprobe field program.




## LEGEND

- PROPOSED SURFACE WATER SAMPLE LOCATION
- PROPOSED SEDIMENT SAMPLE LOCATION (DEPTH 0-0.5 ft.)
- PROPOSED SEDIMENT SAMPLE LOCATION (DEPTH 0-0.5 ft. AND 2.0 ft.-2.5 ft.)
- PROPOSED SURFACE SOIL SAMPLING LOCATION
- * SDB-6 SAMPLE LOCATION IS RESERVED FOR FIELD CONFIRMATION

SOURCE: LANTDIV, OCTOBER 1991

# FIGURE 3-6
# PROPOSED SURFACE WATER/SEDIMENT/ SURFACE SOIL SAMPLING LOCATIONS
# CAMP ALLEN LANDFILL - AREA B
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

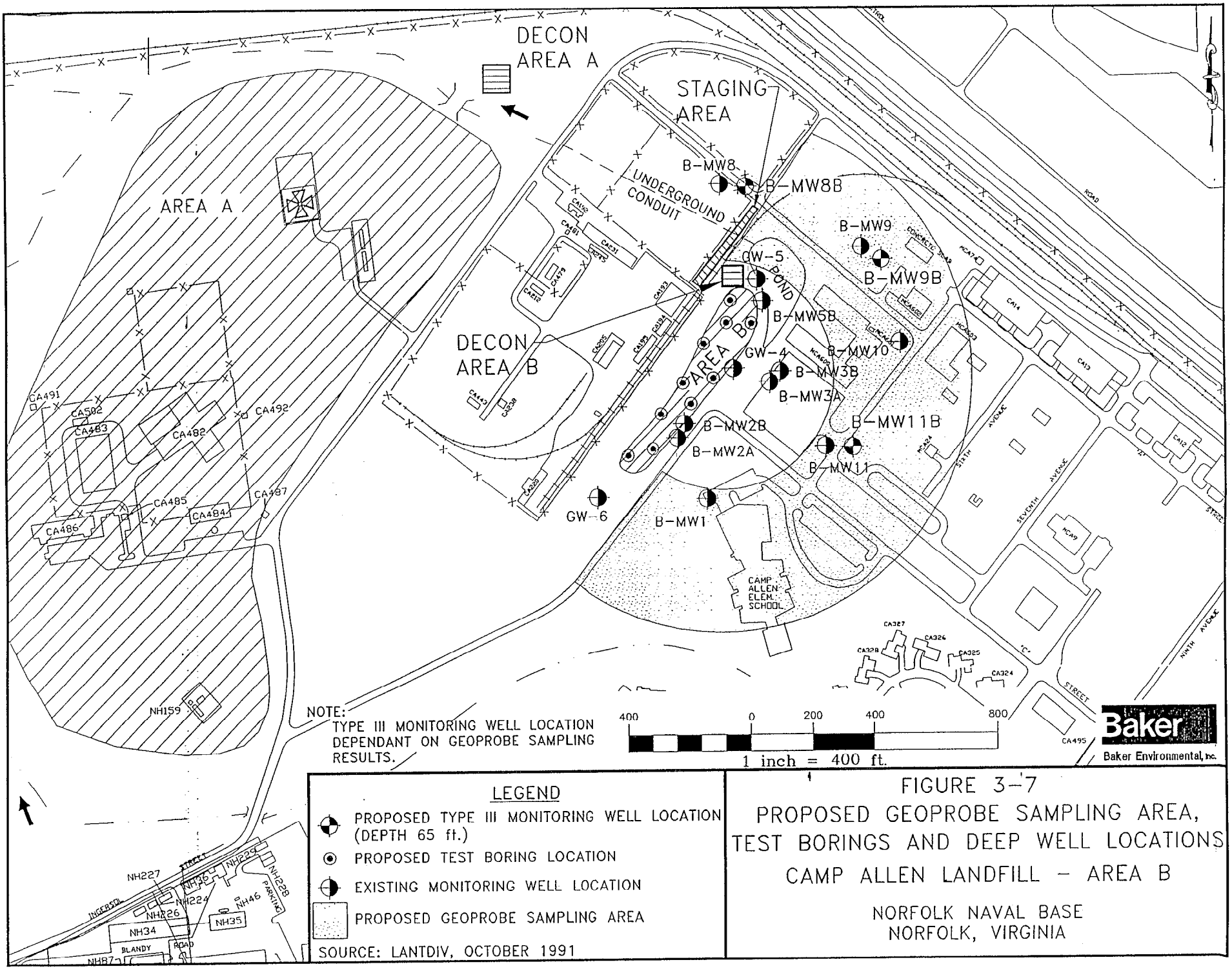



FIGURE 3-7
PROPOSED GEOPROBE SAMPLING AREA, TEST BORINGS AND DEEP WELL LOCATIONS
CAMP ALLEN LANDFILL - AREA B

NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

### 3.2.3 Drilling and Monitoring Well Installation

A series of monitoring wells will be installed to determine the extent of groundwater contamination. Shallow well locations will be determined during the site visit and by in-situ groundwater sampling (Geoprobe) results. The wells will be installed as follows:

- Five 25-foot deep monitoring wells will be installed at locations determined by the results of the Geoprobe investigation (in-situ groundwater sampling).

- Three 65-foot deep monitoring wells will be installed at near shallow monitoring wells, B-MW8, B-MW9 and B-MW11.

Figure 3-7 presents Area B monitoring well locations/anticipated areas. It should be noted that shallow monitoring well locations are dependent upon Geoprobe investigation results.

### 3.2.4 Characterize Source Contamination at Area B

As part of the Source Characterization Task, a magnetometer or Ground Penetrating Radar (GPR) survey will be performed to determine if any drums or buried metal are present.

Based on the results of the geophysical survey at Area B, the following activities will be performed:

- Ten borings will be drilled to a depth of approximately 10 feet. It is assumed drilling will be performed in elevated levels of personal protective equipment (Level C or Level B).

- Soil samples will be screened for volatile organic vapors using an HNu photoionization detector (PID).

- One subsurface soil sample from each borehole will be submitted to the laboratory for chemical analysis. Analyses will include TCL and TAL parameters.

Figure 3-7 presents boring locations at Area B.

### 3.2.5 First Round Groundwater Sampling Event

Subsequent to well development, three newly installed 65-foot deep wells will be sampled during this event. Samples will be analyzed for VOCs using EPA Method 601. This method utilizes a gas chromatograph (GC) to screen for halogenated VOCs.

A local (non-NEESA certified) laboratory will be used to analyze the samples on a two to three day accelerated turn around basis. Per LANTDIV's direction, wells will be developed and sampled not less than 24 hours after installation.

### 3.2.6 Groundwater Sampling - Round 2 and Round 3

Round 2 - Sixteen shallow and six deep monitoring wells will be sampled and analyzed for the TCL and TAL compounds, chloride, sulfate, and alkalinity. Contract Laboratory Program protocols (Level D QA/QC) will be used during analysis.

Round 3 (Optional) - Three existing deep wells, three newly installed deep wells, and five newly installed shallow wells will be sampled during this event. Samples will be analyzed for the TCL volatile organic compounds only. It is assumed that the other compounds will not be detected in significant concentrations to require continued monitoring. Contract Laboratory Program protocols (Level D QA/QC) will be used during analysis.

Static water level will be measured in all existing and newly installed wells during each sampling event. Measurements will be obtained from top of casing to determine groundwater elevation. Additionally, measurements will be obtained from staff gauges installed during the previous investigation.

### 3.2.7 Land Surveying

Fourteen existing monitoring wells and eight newly installed monitoring wells will be surveyed for vertical control and horizontal control. Additionally, site structures (i.e., staff gauges) will be surveyed as required.

### 3.2.8 Slug Test

An in-situ hydraulic conductivity test (slug test) will be performed on six of the eight newly installed monitoring wells at Area B. The six wells at Area B will be selected in the field. One rising head test and one falling head test will be conducted on each well (See Section 3.1.10).

## 3.3 Sample Analysis

All identified samples will be analyzed following NEESA standard methods. The appropriate number of field QA/QC samples, including field blanks, rinsate blanks, and duplicates/ replicates will be analyzed in addition to laboratory QA/QC samples, including matrix spike and matrix spike duplicate samples. The Sampling and Analysis Plan details QA/QC sampling requirements.

A subcontracted NEESA-certified laboratory will be used to perform the sample analysis. Baker personnel will be responsible to track analysis of the samples and obtain results from the laboratory. Three sampling events are anticipated for each area under investigation, with a minimum time of three months between the second and third event. Note that per LANTDIV's SOW for surface water and groundwater samples will be analyzed for dissolved and total metals. Table 3-2 presents environmental and QA/QC samples for all phases of the subject investigation. The table is broken down by Area/Round and sampling media.

## 3.4 Data Validation

An independent data validation firm will be subcontracted to data validation. Samples collected during the field investigation will be analyzed using Level D quality control. Data review procedures specified by NEESA 20.2-047B will be followed to ensure that raw data are not altered and that an audit trail is developed for those data which require reduction. Specific QA/QC procedures will be presented in the QAP. Note that per LANTDIV's SOW only 10 percent of the analytical data generated from the field investigation will be validated by a data validation subcontractor.

## 3.5 Data Assembly/Interpretation (Optional)

This task involves efforts related to the data once it is received by the laboratory and validated. It also involves the evaluation of any field-generated data including: water level

TABLE 3-2

SUMMARY OF ENVIRONMENTAL SAMPLES*

| Site Location | Sample Type | Media/No. of Locations | No. of Samples per Location | VOCs (Method 601) | VOCs (Method 624) | TCL VOCs | TCL Semi-volatiles | Pesticide/ PCBs | TAL (Dissolved) Metals | TAL[1] (Total) Metals | Selected Metals[2] | Chloride | Sulfide | Alkalinity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Area A | Residential Wells | Aqueous/5[3] | 1 | | | 5 | | | | | | | | |
| | Subsurface Soil | Solid/8 | 1 | | | 8 | 8 | 8 | | | | | | |
| | Surface Water | Aqueous/8 | 1 | | | 8 | 8 | 8 | 8 | 8 | | 8 | 8 | 8 |
| | Sediment 0-.5' | Solid/20 | 1 | | | | | | | | 20 | | | |
| | 2-2.5' | Solid/6 | 1 | | | | | | | | 6 | | | |
| | Groundwater | | | | | | | | | | | | | |
| | Round 1[4] | Aqueous/9 | 1 | 7 | 2 | | | | | | | | | |
| | Round 2[5] | Aqueous/32 | 1 | | | 32 | 32 | 32 | 31 | 32 | | 31 | 31 | 31 |
| | Round 3 (opt.)[5] | Aqueous/15 | 1 | | | 15 | | | | | | | | |
| Total Samples Area A | | | | 7 | 2 | 88 | 48 | 48 | 39 | 40 | 26 | 39 | 39 | 39 |
| Area B | Subsurface Soil | Solid/10 | 1 | | | 10 | 10 | 10 | | 10 | | | | |
| | Surface Water | Aqueous/5 | 1 | | | 5 | 5 | 5 | 5 | 5 | | | | |
| | Sediment 0-.5' | Solid/6 | 1 | | | 6 | 6 | 6 | | 6 | | | | |
| | 2-2.5' | Solid/2 | 1 | | | 2 | 2 | 2 | | 2 | | | | |
| | Surface Soil | Solid/3 | 1 | | | | | | | 3 | | | | |
| | Geoprobe | Aqueous/25 | 1 | 25 | | | | | | | | | | |
| | Groundwater | | | | | | | | | | | | | |
| | Round 1[4] | Aqueous/3 | 1 | 3 | | | | | | | | | | |
| | Round 2[5] | Aqueous/22 | 1 | | | 22 | 22 | 22 | 22 | 22 | | 22 | 22 | 22 |
| | Round 3 (opt.)[5] | Aqueous/11[6] | 1 | | | 11 | | | | | | | | |
| Total Samples Area B | | | | 28 | | 56 | 45 | 45 | 27 | 48 | | 22 | 22 | 22 |
| Total Areas A and B | | | | 35 | 2 | 144 | 93 | 93 | 66 | 102 | 26 | 61 | 61 | 61 |

TABLE 3-2 (Continued)

QA/QC SAMPLE SUMMARY

| Task | Media | No. of Environmental Samples | Duplicate (Aqueous) | Replicate (Solid) | Matrix Spike/Matrix Spike Duplicate | Equipment Rinsate | Trip Blanks | Field[7] Blanks |
|---|---|---|---|---|---|---|---|---|
| Area A | | | | | | | | |
| Residential Wells | Aqueous | 5 | 1 | | | | 2 | |
| Subsurface Soil | Solid | 8 | | 1 | 2 | 4 | 4 | 2 |
| Surface Water. | Aqueous | 8 | 1 | | 2 | 1 | 4 | 2 [8] |
| Sediment: 0-.5' | Solid | 20 | | 2 | 1 | 1 | | |
| 2-2.5' | | 6 | | 1 | 1 | 1 | | 2 |
| Groundwater | | | | | | | | |
| Round #1 [4] | Aqueous | 9 | 1 | | | | 9 | |
| Round #2 [5] | | 32 | 4 | | 4 | 6 | 18 | 2 |
| Round #3 [5] | | 15 | 2 | | 2 | 2 | 2 | 2 |
| TOTAL AREA A | | 103 | 9 | 4 | 12 | 15 | 39 | 10 |
| Area B | | | | | | | | |
| Subsurface Soil | Solid | 10 | | 1 | 2 | 5 | 8 | |
| Surface Water | Aqueous | 5 | 1 | | 2 | 1 | 3 | |
| Sediment: 0-.5' | Solid | 6 | | 1 | | | | |
| 2-2.5' | | 2 | | 1 | 1 | 1 | 1 | |
| Surface Soil | Solid | 3 | | (9) | 1 | (9) | (9) | |
| Geoprobe | Aqueous | 25 | 3 | | | | 3 | |
| Groundwater | | | | | | | | |
| Round #1 [4] | Aqueous | 3 | 1 | | | | 3 | |
| Round #2 [5] | | 22 | 3 | | 4 | 4 | 17 | |
| Round #3 [5] | | 22 | 3 | | 2 | 3 | 3 | |
| TOTAL AREA B | | 87 | 10 | 3 | 14 | 14 | 38 | |
| TOTAL AREAS A AND B | | 190 | 19 | 7 | 26 | 29 | 77 | 10 |

* Optional air samples at Brig - 15 samples to be determined.

(1) Forty (40) samples at Area A and 27 samples at Area B for total metals analysis reflect the Mod. 2 scope of work.

(2) Selected metals analysis will include: arsenic, beryllium, cadmium, chromium, lead, mercury, selenium, silver, and vanadium.

(3) Residential wells (Area A) - Number of samples changed from 25 to 5 to reflect Mod. 2 scope of work.

(4) Round 1 GW - Areas A & B - non-NEESA QA/QC

(5) Analysis will be performed (in Rounds 2 and 3) under Level D QA/QC.

(6) Area B - Round 3 samples changed from 22 to 11 to reflect Mod. 2 scope of work.

(7) Two sources of water (potable and deionized) will be analyzed for each parameter/each round.

(8) Metals only.

(9) Surface soil replicate, rinsate and trip blanks at Area B are included in sediment QA/QC totals.

measurements, in-situ permeability tests, test boring logs, and other field notes. Efforts under this task will include the tabulation of validated data and field data, generation of test boring logs and monitoring well construction logs, generation of geologic cross-section diagrams, and generation of other diagrams associated with field notes or data received from the laboratory (e.g., sampling location maps, isoconcentration maps).

### 3.6 Baseline Risk Assessment (Optional)

A Baseline Risk Assessment will be performed for all media at the Camp Allen Landfill (Areas A and B) using all available data collected prior to the Draft RI Report. The Baseline Risk Assessment shall evaluate the remedial alternatives at each of the areas. The Baseline Risk Assessment will conform to EPA's "Risk Assessment Guidance for Superfund", both Volume I - Human Health Evaluation Manual" and Volume II - Environmental Evaluation Manual" (March 1989 Interim Final or most recent version). The results of the human health risk assessment will be documented in the RI report.

### 3.7 Remedial Investigation Report (Optional)

This task is intended to cover all work efforts related to the preparation of the findings once the data have been evaluated. The task covers the preparation of a draft, revised draft, and final RI report.

One RI report will be prepared and include a summary and interpretation of all data gathered, including applicable data from previous studies. The report will discuss the overall program and site history. Site specific sections will include site description, site maps showing sample locations and groundwater contours, a summary of the sampling plan for each site, analytical data in tabular form, and laboratory QA/QC data.

### 3.8 Feasibility Study (Optional)

A Feasibility Study will be performed for both Camp Allen Landfill areas. The objective of the study is to select and describe a remedial action appropriate for mitigating confirmed environmental contamination.

Meeting this objective will require the preparation of a Feasibility Study Report, which will provide necessary data, direction and documented supportive rationale to acquire regulatory

concurrence at federal, state, and local levels with the recommended remedial alternatives. Refer to Section 4.0 Remedial Action Alternatives Development.

### 3.9 Feasibility Study Report (Optional)

The task covers the preparation of a draft, and final FS report. This task involves reporting the findings of the Feasibility Study describing the screen control measures, development of detailed alternatives, evaluation of detailed alternatives, and description of selected alternatives.

If appropriate, the content of the report will include an introduction, environmental setting, field program, discussion of the results and significant findings, alternative measures, and recommendations. Refer to Section 4.0 Remedial Action Alternatives Development.

### 3.10 Meetings

The BAKER Project Manager and Project Geologist/Field Coordinator shall attend three Activity meetings, including an initial meeting/site visit, three advisory panel meetings, and one TRC meeting as part of this CTO.

## 4.0 REMEDIAL ACTION ALTERNATIVES DEVELOPMENT (Optional)

Consistent with the NCP and in accordance with SARA, the Feasibility Study (FS) will utilize the findings of the Remedial Investigation to develop and evaluate alternative remedial measures for the Camp Allen Landfill Site. The major tasks associated with conducting an FS which are outlined below include: (1) Development and Screening of Remedial Action Alternatives, (2) Detailed Analysis of Remedial Alternatives, and (3) Feasibility Study Report.

### 4.1 Development and Screening of Remedial Action Alternatives (Optional)

The overall objective of this task is to develop a set of remedial action alternatives that address contamination at a site. The set of alternatives will then undergo full detailed analysis. This task begins when there is sufficient data available to initiate the identification of potential remedial action technologies, and when target cleanup levels for the site remediation can be concluded from the risk assessment. This task involves six general steps: (1) the development of remedial action objectives; (2) development of general response actions for each medium of interest; (3) identification of volumes or areas of media which general response actions might be applied; (4) identification and screening of technologies applicable to each general response action; (5) identification and evaluation of technology process options to select a representative process for each technology type retained for consideration; and (6) assemble selected technologies into alternatives representing a range of treatment and containment combinations. As required by the NCP, a no action alternative will be carried through the entire FS process.

Treatment alternatives may range from an alternative that, to the degree possible, would eliminate the need for long-term management (including monitoring) at the site, to alternatives that would primarily reduce toxicity, mobility, or volume. Containment alternatives may range from excavation and off-site disposal of contaminated media to in situ isolation of waste materials via installation of physical barriers.

In order to reduce the number of alternatives evaluated in the detailed analysis, the set of potential alternatives will be subject to a preliminary screening to identify and distinguish differences among various alternatives and to evaluate each alternative with respect to their effectiveness, implementability, and cost. Individual remedial alternatives will be researched through available literature from similar remedial investigations, feasibility studies, and remedial action projects. Technologies which have proved cost-effective and implementable on

other similar projects, or those that have been demonstrated or appear to be reliable, will be retained for the detailed evaluation. Technologies determined to be too costly or too difficult to implement, and will not achieve the remediation goals within a reasonable time period, will be eliminated from further consideration. Only the alternatives judged as the best or the most promising on the basis of these evaluation factors will be retained for further consideration and analysis.

For reporting and tracking purposes, this task is defined as complete when a final set of alternatives is chosen for detailed evaluation.

## 4.2 Detailed Analysis of Remedial Alternatives (Optional)

This task includes the detailed analysis of the remedial action alternatives brought through the screening discussed previously. The objective of this task is to provide sufficient information to compare alternatives and select an appropriate alternative for a site. This task involves the evaluation of the potential alternatives with respect to the nine criteria listed below:

- Threshold Criteria: Overall protection of human health and the environment; Compliance with ARARs;
- Primary Balancing Criteria: Long-term effectiveness and permanence; Reduction of toxicity, mobility, and volume; Short-term effectiveness; Implementability; Cost;
- Modifying Criteria: State acceptance; Community acceptance.

The results of this assessment will be used to compare the alternatives and identify the key tradeoffs among them. Therefore, this evaluation will provide the basis for identifying a preferred alternative and preparing the proposed plan.

## 4.3 Feasibility Study Report (Optional)

This task involves reporting the findings of the Feasibility Study. The task covers the preparation of a Draft, and Final FS report. The FS report will include a summary of the screenings and evaluations conducted on the technologies and alternatives. The table of contents of the FS report may include but will not be limited to the following sections:

- Introduction (including purpose of the report and site background);
- Identification and Preliminary Screening of Technologies (including remedial action objectives, general response actions, identification of technologies, screening of technologies and process options);
- Development of Remedial Action Alternatives;
- Detailed Analysis of Alternatives (including individual and comparative analysis);
- Summary of Detailed Analysis; and
- References and Appendices.

A separate FS report will be prepared for Area A and Area B at the Camp Allen Landfill Site.

## 5.0 PROJECT MANAGEMENT

Project Management involves such activities as daily technical support and oversight, budget and schedule review and tracking, preparation and review of invoices, personnel resources planning and allocation, and coordination with LANTDIV, the Activity, and subcontractors. Also included in this task are the costs for attendance by the BAKER Project Manager and Project Geologist/Field Coordinator for three Activity meetings, including an initial meeting/site visit, three advisory panel meetings, and one TRC meeting as part of this CTO.

The Baker Activity Coordinator will have as primary responsibilities: 1) monitoring technical, cost and schedule performance, 2) orchestrating Baker's overall QAS efforts -- audit, document reviews, cost/schedule reviews -- with the Program Manager, audit, and senior technical staff; and 3) maintaining close communication with the LANTDIV EIC and Naval Base, Norfolk project officer. Project organization is shown on Figure 5.1.

Due to the size and complexity of the field program, field coordination and site staging is a very important consideration. Field coordination will be primarily initiated at the central staging area located southeast of the salvage yard (Figures 3-1 through 3-7). Coordination of all drilling, sampling and surveying activities will initially be conducted at the staging area during the daily briefings.

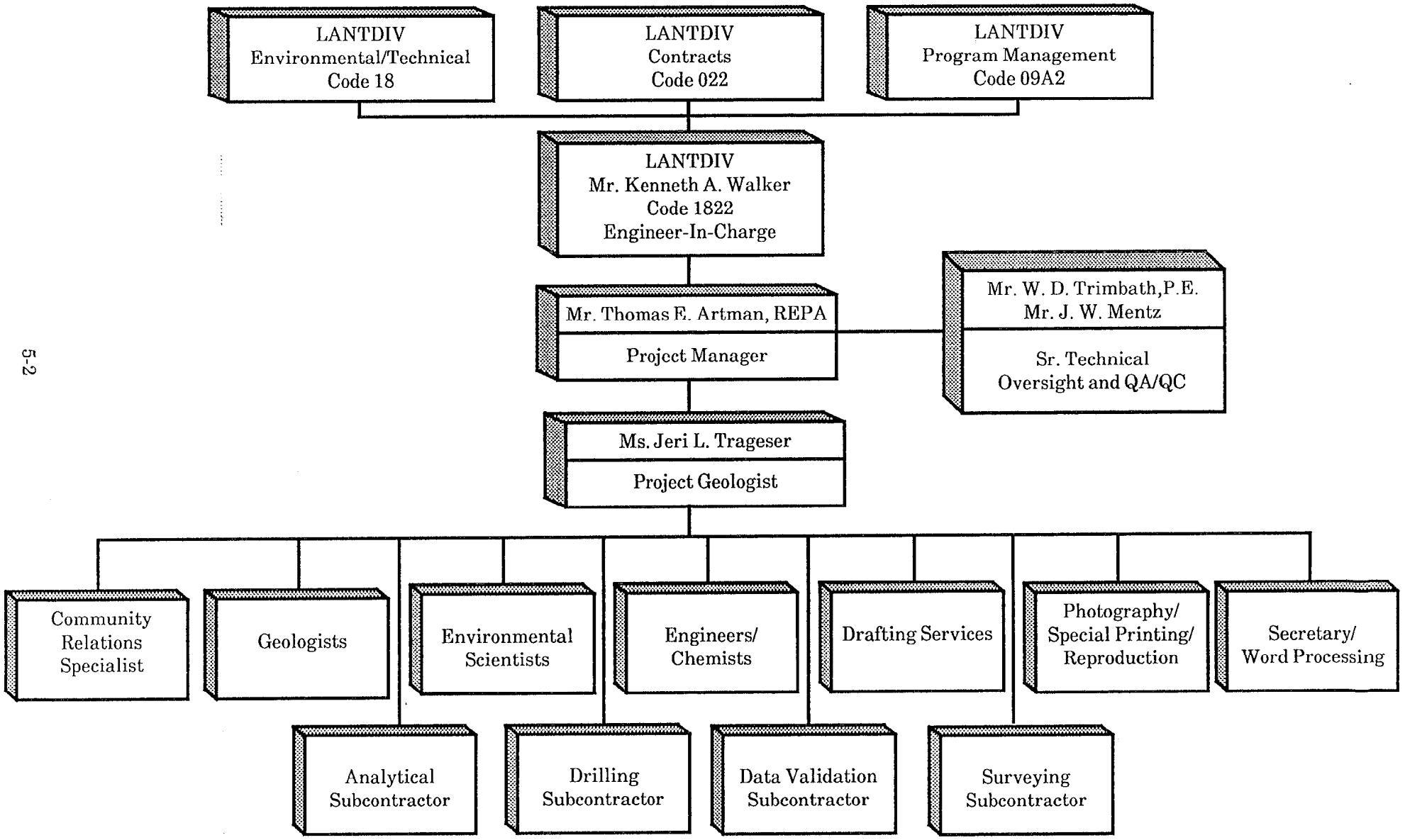
The staging area will cover approximately 5,000 square feet in order to accommodate the storage of drilling equipment, monitoring well equipment, health and safety equipment and supplies and all sampling equipment, materials and supplies. Additionally, Baker's support trailer, portable lavoratory facilities, and drum storage will occupy this area.

Prior to set up of the staging area, arrangements covering the identification of an electrical source, water source, site security (i.e., temporary fencing), telephone service and site entrance must be established with LANTDIV and the Activity.

Items which LANTDIV and/or the Activity need to provide consist of clearance for off-site well locations, residential well sampling and schoolyard soil sampling authorization, and any other arrangements/approvals such as access to the Brig grounds, and the scheduling of any required meetings.

FIGURE 5-1

PROJECT ORGANIZATION

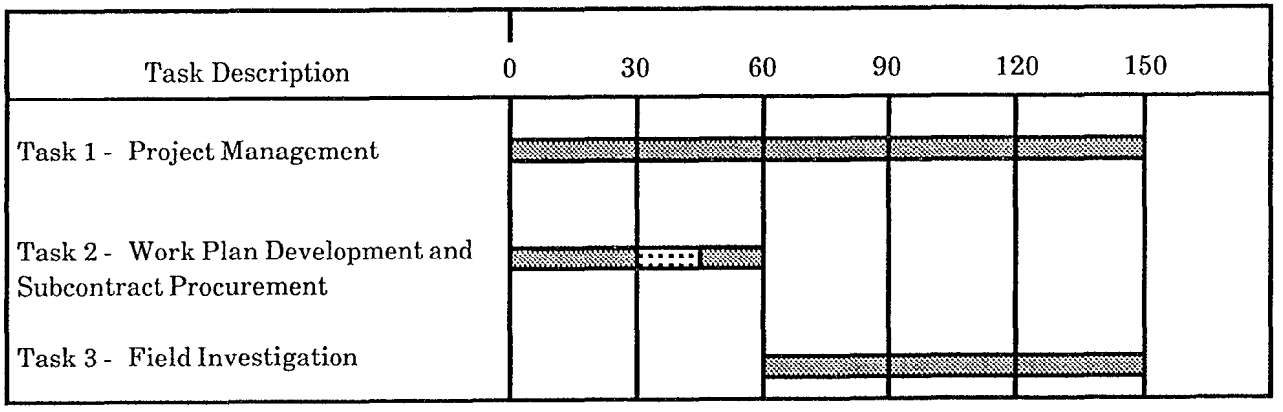


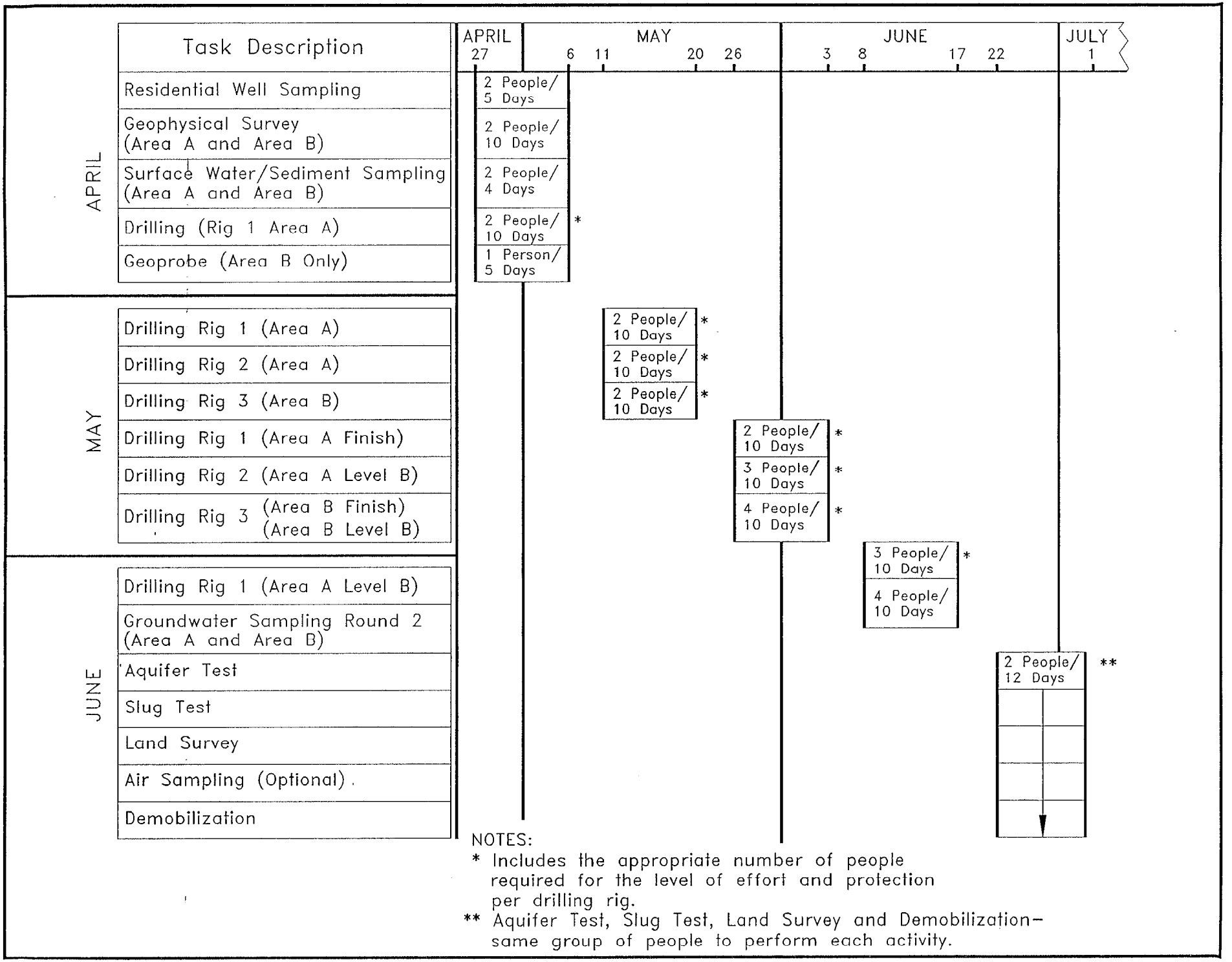
## 6.0 SCHEDULE

This project will be performed in accordance with the schedules and milestones presented in Figure 6-1. Figure 6-2 presents a breakdown of field activities during each 10-day work period.

**FIGURE 6-1**

**PROJECT SCHEDULE**






NOTES:

* Includes the appropriate number of people required for the level of effort and protection per drilling rig.

** Aquifer Test, Slug Test, Land Survey and Demobilization- same group of people to perform each activity.

## 7.0 REFERENCES

CH2M Hill, (1991), Site Summary for Area A and Area B.

Malcolm Pirnie, Inc., (1987), NACIP Program Confirmation Study - Sewell's Point Naval Complex, Norfolk, Virginia. Contract N62470-83-C-6079.

Malcolm Pirnie, Inc., (June 1984), NACIP Program Confirmation Study - Site Suitability Assessment, Proposed Brig Expansion (P-977), Naval Station, Norfolk, VA.

# FINAL
# HEALTH AND SAFETY PLAN

## CAMP ALLEN LANDFILL SITE
## (AREAS A AND B)
## NORFOLK, VIRGINIA

## CONTRACT TASK ORDER 0084

*Prepared For:*

**NAVAL FACILITIES**
**ENGINEERING COMMAND**
**ATLANTIC DIVISION**
*Norfolk, Virginia*

*Under:*

**Contract N62470-89-D-4814**

*Prepared By:*

**BAKER ENVIRONMENTAL, INC.**
*Coraopolis, Pennsylvania*

**APRIL 23, 1992**

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## ATTACHMENTS

## 1.0 INTRODUCTION

### 1.1 Background

Baker Environmental, Inc., (Baker) will perform a Remedial Investigation/Feasibility Study (RI/FS) for the Camp Allen Landfill Site (Areas A and B), Norfolk Naval Base, Norfolk, Virginia (See Figure 1). Operations at the Camp Allen Landfill (Area A) were conducted from the early 1940s until about 1974 to dispose of a variety of materials. It is estimated that approximately 40,000 pounds of metal plating sludges, 60,000 pounds of parts cleaning sludges, and 400,000 pounds of paint stripping residues were disposed. Other materials disposed of at the site include incineration ash, fly and bottom ash from the Navy power plant, overage chemicals, chlorinated organic solvents, acids, caustics, paints, paint thinners, pesticides, asbestos, scrap metal and construction and demolition debris.

In 1971, a fire in a salvage yard located between landfill Areas A and B occurred where waste lubricating oils, organic solvents, paints, paint thinners, acids, caustics, and pesticides were stored. It was reported that the burned material, smoldering residue from the fire and residual waste, which was not burned, were buried just east of the salvage yard in Area B. Some of these materials were reportedly drummed or containerized. The trenches used for landfilling in Area B are reportedly about 150 feet long, six to eight feet deep and 10 feet wide.

At present, the majority of Area A and all of Area B is capped with a grass cover to minimize surface erosion. Area A incorporates the Navy Brig facility in addition to a heliport built over a portion of the landfill. Area B is located between a salvage yard and the Camp Allen Elementary School. Both areas are adjacent to tidal drainage ditches which convey runoff to Willoughby Bay via Boush Creek.

### 1.2 Policy

It is the policy of Baker that all on-site hazardous waste management activities be performed in conformance with a Site-Specific Health and Safety Plan (HASP). The HASP applies to activities performed by Baker and Subcontractor personnel. It is the responsibility of the Subcontractor to provide his/her own PPE that meets or exceeds the level of protection as outlined in this HASP. Additionally, Subcontractor personnel are responsible for complying with the surveillance and training requirements as outlined in sections 1.3 and 1.4,

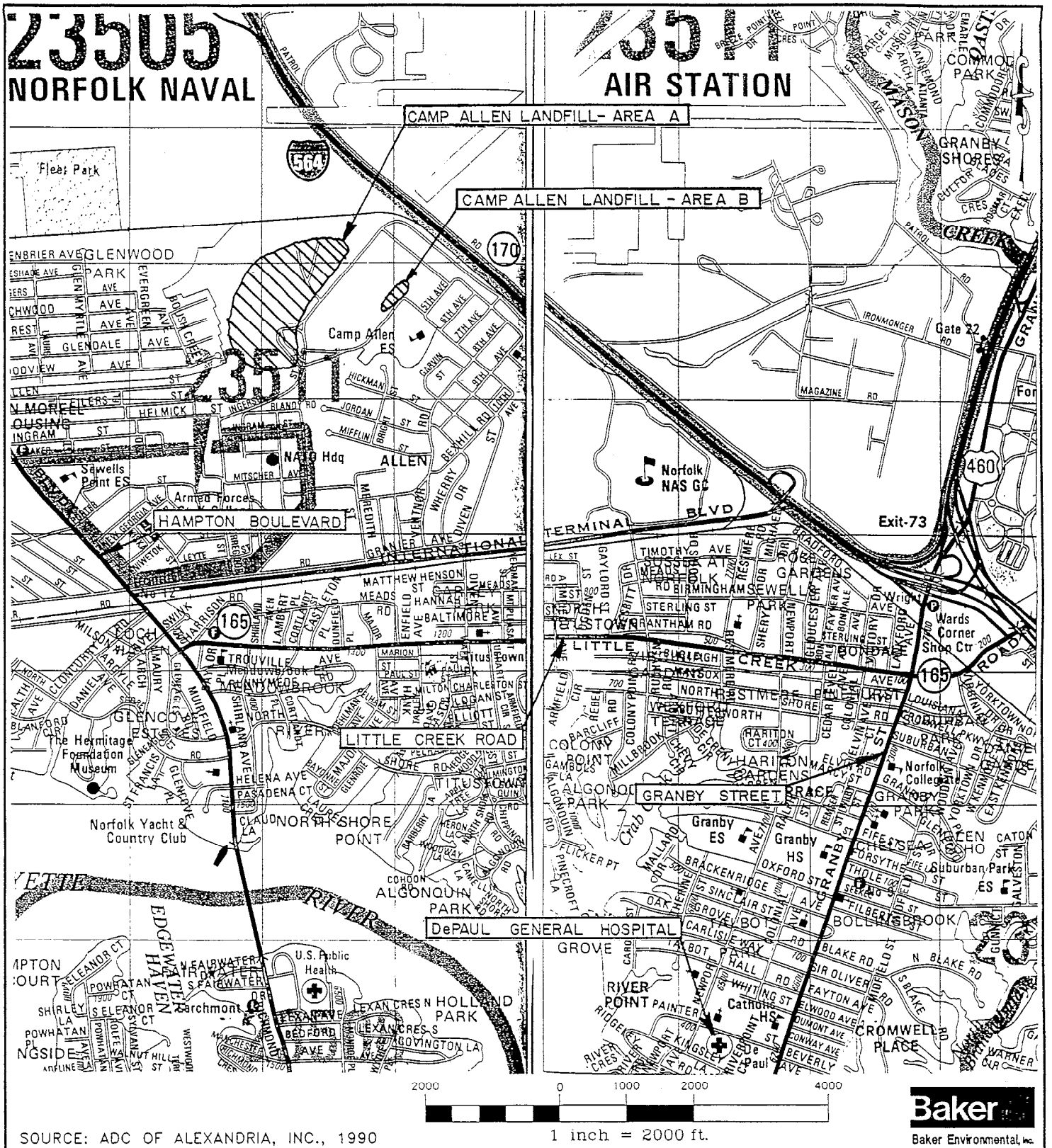


FIGURE 1
SITE LOCATION MAP
CAMP ALLEN LANDFILL
AREAS A and B
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

respectively. The SHSO will audit subcontractor records to verify compliance with surveillance and training requirements.

The Site Health and Safety Officer (SHSO) or qualified designee will be responsible for continually evaluating safety at the site and ensuring adherence to the HASP. The SHSO or designee, in addition to the Site Manager, is directly responsible for safety issues relevant to the site, and the SHSO has the immediate authority to modify the existing HASP as site conditions warrant. Modifications are to be documented and changes made to the HASP after review with the Project Manager and the Navy's Engineer-in-Charge (EIC). The SHSO, or designee, will be responsible for the preparation of a daily report which includes all relevant health and safety events; recordkeeping of all personnel and site monitoring information; accident investigation and reporting; daily safety talks and inspections; and any other relevant health and safety issues. The HASP may be modified/updated with the approval of the Project Health and Safety Officer (PHSO) and Project Manager. Proper notification will be given to the Navy EIC when such changes to the plan are implemented.

## 1.3 Medical Surveillance Requirements

An essential requirement of the Site-Specific HASP is to provide that project personnel, who may be exposed to materials having potentially adverse and deleterious health effects, will be medically certified and adequately trained prior to entry onto the site. Baker's corporate medical surveillance program has been developed to establish a medical baseline and to monitor for symptoms of overexposure for individuals who participate in Preliminary Assessments, Site Inspections, Remedial Investigations, Feasibility Studies, and construction-phase services at sites covered by the Department of Labor, Occupational Safety and Health Administration (OSHA), Hazardous Waste Operations and Emergency Response Standard, 29 CFR 1910.120. Additionally, the program is intended to determine the individual's capability for performing on-site work, including wearing respiratory protective equipment.

All individuals engaged in site activities covered by the 1910.120 standard receive a physical examination by a licensed physician who is provided information on the individuals site activities, and exposure or anticipated exposure levels. A complete medical exam is given which includes parameters such as height, weight, vision, temperature, and blood pressure, including a complete review of occupational and medical histories. Other information obtained to satisfy the protocols for OSHA Standard 1910.120 include chest x-rays, electrocardiogram, pulmonary function test, urinalysis, and blood tests. Attachment A

describes the medical surveillance testing parameters performed annually on Baker employees.

Subcontractor personnel are required, at a minimum, to meet the medical monitoring requirements previously discussed in this section.

## 1.4 Training Requirements

Baker assures that all personnel who work on site will be initially trained at a health and safety training course, meeting the requirements outlined in 29CFR 1910.120. These requirements state: "General site workers (such as equipment operators, general laborers and supervisory personnel) engaged in hazardous substance removal or other activities which expose or potentially expose workers to hazardous substances and health hazards shall receive a minimum of 40 hours of instruction off the site, and a minimum of three days actual field experience under the direct supervision of a trained, experienced supervisor." These are generally 5-day (40-hour) courses. Key points of the 40-hour training include field demonstrations, respiratory fit testing and training, risk assessment, toxicology, chemical reactivity, use of monitoring equipment, downrange work procedures, site safety procedures, levels of protection, protective clothing, decontamination, and practical field exercises (which include donning, doffing, and working in personal protective ensembles for personal protection Levels A, B, and C).

In addition to the initial 40-hour training program, OSHA requires general site workers to receive an annual 8-hour refresher training course on the items specified by the 1910.120 standard. The general purpose of the 8-hour refresher is to ensure that personnel retain the knowledge necessary to be adequately protected, and stay current with proper site health and safety procedures.

OSHA also requires that personnel involved with on-site management and supervisors directly responsible for, or who supervise employees engaged in hazardous waste operations, shall receive (in addition to 40 hours initial training and three days of supervised field experience) at least eight additional hours of specialized training at the time of job assignment on such topics as, but not limited to, the employer's safety and health program and the associated employee training program, personal protective equipment program, spill containment program, and health hazard monitoring procedures and techniques. The 8-hour supervisory training is required to ensure that supervisors have the knowledge necessary to

understand and use the various Health and Safety Programs, and to implement the elements of the HASP. Attachment B provides the appropriate "OSHA" Health and Safety Training History for Baker Project Personnel. Training records for Subcontractor personnel will be accumulated prior to site startup and maintained at the on-site command post.

## 1.5 Pre-Entry Requirements

During the initiation of site activities (site set-up), the SHSO will perform a reconnaissance of the on-site and off-site sampling areas, after which the SHSO will call a meeting with Baker on-site personnel and the subcontractor's personnel. Site-specific safety and health hazards, data obtained from the site reconnaissance, provisions outlined in this HASP, and appropriate safety and health related procedures/protocols will be reviewed by the SHSO. Prior to each phase of site operation (new sampling task), the SHSO will brief the appropriate site workers on the health and safety hazards and protection strategies. The SHSO will be available to address potential emergencies, unforeseen circumstances, and implement appropriate changes to the HASP.

All Baker employees and subcontractor personnel will be responsible for familiarity with the requirements and provisions of the HASP including modifications. Any and all modifications will be clearly posted to alert all site personnel in addition to notification via daily briefings.

Baker believes that the development of a HASP is necessary to ensure adequate protection for on-site personnel. The following HASP has been based on an outline developed by the U.S. Coast Guard for responding to hazardous chemical releases (U.S.C.G. Pollution Response COMDTINST-ML6456-30) and by NIOSH, OSHA, USCG, and EPA's recommended health and safety procedures (Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities). This plan, at a minimum, meets the requirements under OSHA Standard 29 CFR 1910.120 (Hazardous Waste Operations and Emergency Response). This plan has been designed as a Site-Specific HASP for the Camp Allen Landfill Site (Areas A and B), Norfolk Naval Base, Norfolk, Virginia.

## 2.0 SITE ORGANIZATION

### 2.1 Project Personnel

The following personnel are designated to carry out the stated job functions for both on- and off-site activities. (Note: One person may carry out more than one job function.)

PROJECT MANAGER Mr. Thomas Artman

PROJECT HEALTH AND SAFETY OFFICER Ms. Barbara Cummings

SITE MANAGER Ms. Jeri Trageser/Mr. Thomas Artman

SITE HEALTH AND SAFETY OFFICER Ms. Barbara Cummings/Mr. Peter Monday

FIELD TEAM LEADER Ms. Jeri Trageser

FIELD TEAM MEMBERS

| | | |
|---|---|---|
| Mr. Richard Dabal | Mr. John Nist | Mr. Donald Shields |
| Ms. Melissa Davidson | Mr. Peter Monday | Mr. John Zimmerman |
| Mr. Mark Kimes | Mr. Richard Aschenbrenner | Ms. Kimberly Harriz |

NAVFACENGCOM REPRESENTATIVES

| | |
|---|---|
| Mr. Kenneth Walker, EIC | (804) 445-4385 |

ACTIVITY/BASE REPRESENTATIVES

| | |
|---|---|
| Ms. Cheryl Barnett, Activity Coordinator | (804) 444-3009 |
| Ms. Sharon Waligora, Alternate Activity Coordinator | (804) 445-6911 |
| Mr. Lamb, Brig Programs Officer | (804) 444-5601 |
| Mr. William Whitmire, Hazardous Waste Dispatcher | (804) 444-7528 |
| Ms. Merrill Ashcraft, Navy On-Scene Coordinator | (804) 445-8851 |

CONTRACTOR(S)

| | |
|---|---|
| Driller: | Hardin Huber, Inc. |
| Surveyor: | Miller-Stevenson & Associates, P.C. |
| Geophysics: | Weston Geophysical, Inc. |
| Geoprobe: | Burlington Environmental, Inc. |

## 2.2 Site Work Plans/Personnel

Work Plans detailing the tasks to be performed at each site can be found immediately attached to the HASP. The name and corresponding function of personnel to be present on site can be found in the table below.

Work party teams consisting of 2-4 persons will perform the following functions:

| Name* | Function |
|---|---|
| Ms. Jeri Trageser/Mr. Thomas Artman | Site Manager |
| Ms. Barbara Cummings/Peter Monday | Site Health and Safety Officer (SHSO) |
| Ms. Jeri Trageser | Field Team Leader/Project Geologist |
| Mr. Donald Shields<br>Mr. John Zimmerman<br>Mr. Richard Aschenbrenner<br>Mr. John Nist<br>Ms. Kimberly Harriz | Site Geologist |
| Ms. Melissa Davidson<br>Mr. Peter Monday<br>Mr. Richard Dabal<br>Mr. Mark Kimes | Environmental Scientist |
| | Drilling Contractor Personnel |
| Mr. Mike Nutting<br>Mr. Mark Blackey | Geophysics Contractor Personnel |
| | Land Survey Contractor Personnel |
| | Geoprobe Contractor Personnel |

*Note: At the time of the HASP Publication, specific site personnel and contractors had not been fully determined. Personnel identified are subject to change.

**All personnel arriving or departing the site will be documented in the field log. All activities on site must be cleared through the Site Manager.**

## 3.0 SITE DESCRIPTION

S.O.# 19084-40-SRN

Submittal Date: April 23, 1992

Location: Camp Allen, Norfolk, Virginia

Area affected:

- Area A - A forty-three acre landfill site used for disposal of an estimated 40,000 pounds of metal plating sludges, 60,000 pounds of parts cleaning sludges, and 400,000 pounds of paint stripping residues; incineration ash, fly and bottom ash from the Navy power plant, overage chemicals, chlorinated organic solvents, acids, caustics, paints, paint thinners, pesticides, asbestos, scrap metal and construction and demolition debris.

- Area B - A two acre landfill site used for disposal of burned material, smoldering residue and residual waste, which was not burned, due to a fire in a salvage yard located between landfill Areas A and B where waste lubricating oils, organic solvents, paints, paint thinners, acids, caustics, and pesticides were stored. The trenches used for landfilling in Area B are reportedly about 150 feet long, six to eight feet deep and ten feet wide.

Surrounding population:

- Area A - The Base Brig Facility and heliport are located within the 43-acre site which is adjacent to tidal drainage ditches conveying stormwater runoff to the Elizabeth River. Glenwood Park, a residential community, is situated west of Area A.

- Area B - Within close proximity to various facilities including a salvage yard located immediately to the west, a barracks facility, park, and the Camp Allen Elementary School located just east/southeast of Area B.

Topography:

- Relatively level terrain with drainage ditches surrounding the property.

Anticipated weather conditions:

- Mild to warm, temperatures ranging from 50 to 75°F.

Additional information:

- An Air Monitoring Program will be performed after completion of field activities to characterize the presence or absence of volatile constituents in and around the Brig Facility. An addendum to this HASP may be prepared at a later date if the scope of these activities require additional HASP considerations.

## 4.0 SITE ENTRY OBJECTIVES

The objective of the initial entry into Areas A and B is to characterize the degree, type, and extent (vertical and areal) of soil, sediment, surface water, and groundwater contamination. A listing of the tasks to be performed is provided in Section 8.1 with detailed, task-specific information provided in the Work Plan.

## 5.0 SITE CONTROL

### 5.1 General Requirements

The Site Manager is designated to coordinate access control and security on site. Perimeters for Areas A and B will be established according to the site boundary procedures identified in Section 5.3, local conditions, and Navy Activity requirements. **Unauthorized personnel are not permitted within these areas.**

### 5.2 Site Conditions

- The prevailing wind conditions are from the west-southwest, although easterly coastal winds are common.
- The on-site Command Post has been established at the Baker Site Trailer. This location will be in the support zone and oriented upwind from the Exclusion Zone (Work Zone).

### 5.3 Work Zones

Work zones shall be established utilizing control boundaries between the Exclusion Zone, the Contamination Reduction Zone (CRZ), and the Support Zone. These boundaries shall be defined as follows:

- Exclusion Zone (Work Zone) - A radius of at least 25 feet (barring obstructions) from Site Investigative Activities.
- Hotline - The boundary between the Exclusion Zone and CRZ.*
- CRZ* - The area between the Exclusion Zone and the Support Zone (located upwind of the Site Investigative Activities).
- Contamination Control Line - The boundary between the CRZ and the Support Zone.
- Support Zone - The outermost area next to the CRZ and upwind of the Site Investigative Activities.

* **Note: A CRZ is required for activities in Level D + protection and higher protection levels.**

Refer to Figure 2 for a "Typical Contamination Reduction Zone Layout."

These boundaries will be demarcated using:

- Colored Boundary Tape or Cones for the Hotline.
- Colored Boundary Tape or Cones for the Decontamination Corridor of the CRZ.
- Colored Boundary Tape for the Contamination Control Line including posted signs and/or barricades indicating "Work Area" or "Authorized Personnel Only".

As site investigation locations vary throughout the project, adjustments will be made accordingly.

## 5.4 Sanitation/Site Precautions

Provisions for sanitation and other precautions to be followed on site can be found in Attachment D - Baker Safety SOPs. Responsibility for compliance with these provisions lies with the Site Manager and/or SHSO.

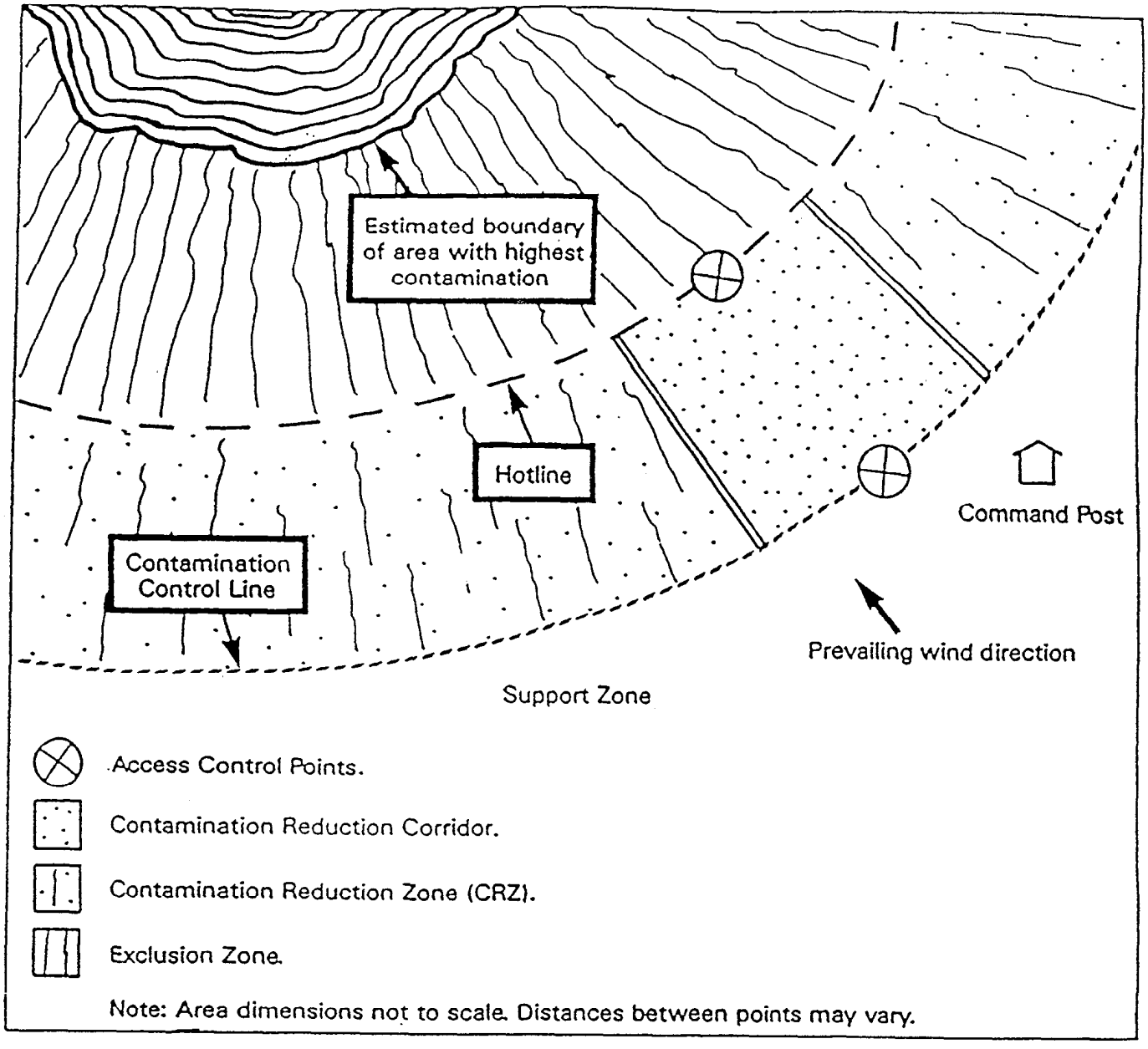


FIGURE 2
TYPICAL CONTAMINATION
REDUCTION ZONE LAYOUT

## 6.0 HAZARD EVALUATION

### 6.1 Preliminary Evaluation

Research into the history of the site under investigation indicates potential site hazards. A summary of the potential chemical, physical, and radiological hazards at this site can be found in Sections 6.2, 6.3, and 6.4, respectively.

### 6.2 Chemical Hazard Analysis

#### 6.2.1 Routes of Entry

Potential routes of entry include inhalation, ingestion (via hand to mouth contact), dermal absorption, and skin or eye contact from:

- Contaminated groundwater, surface water and sediments. (Refer to Tables 1 and 2 in Section 6.2).
- Potentially contaminated soil.

Potential Hazards associated with exposure to radiation (alpha particles via inhalation or ingestion, beta particles via inhalation or penetration, and gamma rays via penetration).

Note: There is no record of radioactive materials being disposed within either of these sites, however, a survey meter will be employed to screen for this potential as a standard operating procedure.

#### 6.2.2 Chemical/Physical Properties

Only the chemical/physical properties of analytes previously detected via sampling during preliminary investigations at the Camp Allen Landfill Site, meeting the criteria outlined below, are identified and further evaluated in Tables 1 and 2, and Section 7.5.4. Additional concerns are identified in Section 6.3.4.

Criteria:

- An analyte regulated by OSHA, or for which exposure guidelines have been published by the ACGIH, NIOSH, or other recognized sources.

## TABLE 1

## TOXICOLOGICAL PROPERTIES OF CHEMICALS/SUBSTANCES DETECTED AT THE CAMP ALLEN LANDFILL SITES

| Chemical/Substance | Source | Exposure Limit (EL)[a] | IDLH[b] | Vapor Pressure[c] | Specific Gravity[d] | Ionization Potential | Routes of Exposure |
|---|---|---|---|---|---|---|---|
| Arsenic (inorganic compounds) | GW and SED | 0.01 mg/m$^3$ | 100 mg/m$^3$ (CA) | 0 | 5.73 | NA | Inhalation, skin absorption, skin/eye contact, ingestion |
| Barium (soluble compounds) | SED | 0.5 mg/m$^3$ | 1100 mg/m$^3$ | low | 3.24 to 3.86 | NA | Inhalation, ingestion, skin/eye contact |
| Benzene | GW | 1 ppm | 3000 ppm (CA) | 75 mm | 0.88 | 9.24 eV | Inhalation, skin absorption, ingestion, skin/eye contact |
| Beryllium | SED | 0.002 mg/m$^3$ | 10 mg/m$^3$ (CA) | 0 | 1.85 | NA | Inhalation |
| Cadmium (as cadmium dust) | GW, SED and SW | 0.2 mg/m$^3$ | 50 mg/m$^3$ (CA) | 0 mm | 8.65 @ 77°F | NA | Inhalation |
| Chromium [as chromium (II and III) compounds] | GW, SED and SW | 0.5 mg/m$^3$ | NA | NA | NA | NA | Ingestion, skin/eye contact |
| Copper | GW and SW | 1 mg/m$^3$ | NA | 0 | 8.94 | NA | Inhalation, ingestion, skin/eye contact |
| Cyanide | GW and SW | 5 mg/m$^3$ | 50 mg/m$^3$ | 0 | 1.55 to 1.60 | NA | Inhalation, skin absorption, ingestion, skin/eye contact |
| 1,1-Dichloroethane | GW | 100 ppm | 4000 ppm | 230 mm @ 77°F | 1.18 | 11.06 eV | Inhalation, ingestion, skin/eye contact |
| 1,2-Dichloroethane (ethylene dichloride) | GW and SED | 1 ppm | 1000 ppm (CA) | 64 mm | 1.24 | 11.05 eV | Inhalation, ingestion, skin absorption, skin/eye contact |

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The EL represents published Exposure Levels according to the following hierarchial order: (1) OSHA PELs; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.
(b) IDLH - Immediately Dangerous to Life or Health.
(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).
(d) Specific Gravity = At 68°F (unless otherwise mentioned).

CA - Suspected or Proven Carcinogen
NA - Not Available
ppm - parts per million (in air)
mg/m$^3$ - milligrams per cubic meter (in air)
GW - Groundwater
Skin - potential for dermal absorption
SW - Surface Water
SED - Sediment

**TABLE 1**
**(Continued)**

**TOXICOLOGICAL PROPERTIES OF CHEMICALS/SUBSTANCES DETECTED AT THE CAMP ALLEN LANDFILL SITES**

| Chemical/Substance | Source | Exposure Limit (EL)[a] | IDLH[b] | Vapor Pressure[c] | Specific Gravity[d] | Ionization Potential | Routes of Exposure |
|---|---|---|---|---|---|---|---|
| trans-1,2-Dichloroethylene (1,2-Dichloroethylene) | GW, SED and SW | 200 ppm | 4000 ppm | 180-264 mm | 1.27 @ 77°F | 9.65 eV | Inhalation, ingestion, skin/eye contact |
| Di-sec-octyl phthalate | GW | 5 mg/m$^3$ | NA (CA) | <0.01 | 0.99 | NA | Inhalation, skin/eye contact, ingestion |
| Ethyl benzene | GW and SED | 100 ppm | 2000 ppm | 10 mm @ 79°F | 0.87 | 8.76 eV | Inhalation, ingestion, skin/eye contact |
| Lead | GW, SED and SW | 0.05 mg/m$^3$ | 700 mg/m$^3$ | 0 mm | 11.34 | NA | Inhalation, ingestion, skin/eye contact |
| Mercury | GW | 0.05 mg/m$^3$ (skin) | 28 mg/m$^3$ | 0.0012 | 13.6 | NA | Inhalation, skin absorption, skin/eye contact |
| Methylene Chloride | GW and SED | 25 ppm* | 5000 ppm (CA) | 350 mm | 1.33 | 11.32 eV | Inhalation, ingestion, skin/eye contact |
| Naphthalene | GW | 10 ppm | 500 ppm | 0.08 | 1.15 | 8.12 eV | Inhalation, skin absorption, ingestion, skin/eye contact |
| Nickel (soluble compounds) | GW and SED | 0.1 mg/m$^3$ | NA (CA) | 0 | 8.90 | NA | Inhalation, ingestion, skin/eye contact |
| Pentachlorophenol | GW | 0.5 mg/m$^3$ (skin) | 150 mg/m$^3$ | 0.0001 | 1.98 | NA | Inhalation, skin absorption, ingestion, skin/eye contact |
| Phenols | GW, SED and SW | 5 ppm (skin) | 250 ppm | 0.4 mm | 1.06 | 8.50 eV | Inhalation, skin absorption, ingestion, skin/eye contact |

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The EL represents published Exposure Levels according to the following hierarchial order: (1) OSHA PELs; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.
(b) IDLH - Immediately Dangerous to Life or Health.
(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).
(d) Specific Gravity = At 68°F (unless otherwise mentioned).

CA - Suspected or Proven Carcinogen
NA - Not Available
ppm - parts per million (in air)
mg/m$^3$ - milligrams per cubic meter (in air)
GW - Groundwater
Skin - potential for dermal absorption
SW - Surface Water
SED - Sediment

*OSHA's proposed PEL

**TABLE 1**
**(Continued)**

**TOXICOLOGICAL PROPERTIES OF CHEMICALS/SUBSTANCES DETECTED AT THE CAMP ALLEN LANDFILL SITES**

| Chemical/Substance | Source | Exposure Limit (EL)[a] | IDLH[b] | Vapor Pressure[c] | Specific Gravity[d] | Ionization Potential | Routes of Exposure |
|---|---|---|---|---|---|---|---|
| Silver (as dust and soluble compounds) | GW and SED | 0.01 mg/m$^3$ | NA | 0 mm | 10.49 | NA | Inhalation, ingestion, skin/eye contact |
| 1,1,2,2-Tetra-chloroethylene (perchloroethylene) | GW and SED | 25 ppm | 500 ppm (CA) | 14 | 1.62 | 9.32 eV | Inhalation, ingestion, skin/eye contact |
| Toluene | GW and SED | 100 ppm | 2000 ppm | 20 mm @ 65°F | 0.87 | 8.82 eV | Inhalation, skin absorption, ingestion, skin/eye contact |
| 1,1,1-Trichlorethane (Methyl chloroform) | GW and SED | 350 ppm | 1000 ppm | 100 mm | 1.34 | 11.00 eV | Inhalation, ingestion, skin/eye contact |
| Trichloroethylene | GW, SED and SW | 50 ppm | 1000 ppm (CA) | 58 mm | 1.46 | 9.45 eV | Inhalation, ingestion, skin/eye contact |
| Trichlorofluoromethane (Fluorotrichloromethane) | GW and SED | 1000 ppm | 10,000 ppm | 690 mm | 1.47 | 11.77 eV | Inhalation, ingestion, skin/eye contact |
| Vinyl Chloride | GW and SED | 1 ppm | (CA) | >1 ATM | NA | 9.99 eV | Inhalation |

(a) EL - Exposure Limit = A time-weighted average concentration for a normal eight-hour work day and 40-hour work week, to which nearly all workers may be repeatedly exposed, day after day, without adverse effect. The EL represents published Exposure Levels according to the following hierarchial order: (1) OSHA PELs; (2) NIOSH RELs; (3) ACGIH TLVs; and, (4) other recognized sources.
(b) IDLH - Immediately Dangerous to Life or Health.
(c) Vapor Pressure = Expressed as mm/Hg at 68°F (unless otherwise mentioned).
(d) Specific Gravity = At 68°F (unless otherwise mentioned).

CA - Suspected or Proven Carcinogen
NA - Not Available
ppm - parts per million (in air)
mg/m$^3$ - milligrams per cubic meter (in air)
GW - Groundwater
Skin - potential for dermal absorption
SW - Surface Water
SED - Sediment

## TABLE 2

## CHEMICAL EXPOSURE INFORMATION

A summary of exposure symptoms for chemicals detected on site are provided in the table below. Material Safety Data Sheets can be found in Attachment C for additional information.

| Substance | Exposure Symptoms |
|---|---|
| Arsenic (inorganic compounds) | Ulceration of nasal septum, dermatitis, GI disturbances, peripheral neuropathy, respiratory irritation, hyperpigmentation of skin, carcinogen |
| Barium (soluble compounds) | Upper respiratory irritations; gastroenteritis; muscle spasm; slow pulse, extrasystoles; hypoglycemia; skin and eye irritations; skin burns |
| Benzene | Eye, nose and respiratory irritation; giddiness, headache, nausea, staggered gait; fatigue, anorexia, lassitude; dermatitis; bone marrow depression; carcinogen |
| Beryllium | Respiratory symptoms, weakness, fatigue, weight loss, carcinogen |
| Cadmium (as cadmium dust) | Pulmonary edema, dyspnea, cough, chest tightness, substernal pain; headache; chills, muscle aches; nausea, vomiting, diarrhea; anosmia, emphysema, proteinuria, mild anemia; carcinogen |
| Chromium (as chromium (II and III) compounds) | Sensitization dermatitis |
| Copper | Irritation of the nasal mucus membrane and pharynx; nasal perforation; eye irritation; metallic taste; dermatitis |
| Cyanide | Asphyxia and death can occur; weakness, headache, confusion; nausea, vomiting; increased rate of respiration; slow gasping respiration; skin and eye irritations |
| 1,1-Dichloroethane | CNS depression; skin irritation; liver and kidney damage |
| 1,2-Dichloroethane (ethylene dichloride) | CNS depression; nausea vomiting; dermatitis; eye irritation, cornea opacity; carcinogen |
| trans-1,2-Dichloroethylene (1,2-Dichloroethylene) | Eye and respiratory irritation; CNS depression |
| Di-sec-octyl phthlate | Irritation of eyes and mucus membrane; carcinogen |
| Ethyl Benzene | Eye and mucus membrane irritation; headache; dermatitis; narcosis, coma |
| Lead | Weakness, lassitude, insomnia; facial pallor; pal eye, anorexia, low-weight, malnutrition; constipation, abdominal pain, colic; anemia; gingival lead line; tremor; wrist and ankle paralysis; encephalopathy; nephropathy; eye irritation, hypertension |
| Mercury | Cough, chest pain, dyspnea, bronchitis pneuitis; tremor, insomnia; irritability, indecision; headache, fatigue, weakness; stomatitis, salivation; GI disorder, anorexia, low-weight; proteinuria; eye and skin irritation |
| Methylene chloride | Fatigue, weakness, sleepiness, lightheadedness; numbness and tingling in limbs; nausea; eye and skin irritant; carcinogen |
| Naphthalene | Eye irritation; headache; confusion, excitement, malaise; nausea, vomiting, abdominal pain; bladder irritation; profuse sweating; jaundice; hematopoietic, hemoglobinuria, renal shutdown, dermatitis |
| Nickel (soluble compounds) | Headache, vertigo; nausea, vomiting, epigastric pain; substernal pain; cough, hyperpnea; cyanosis; weakness; leukocytosis, pneuitis; delirium, convulsions; carcinogen |
| Pentachlorophenol | Eye, nose and throat irritation; sneezing, coughing; weakness, anorexia, low-weight; sweating; headache, dizziness; nausea, vomiting; dyspnea, chest pain; high fever; dermatitis |

TABLE 2 (Continued)

CHEMICAL EXPOSURE INFORMATION

| Substance | Exposure Symptoms |
|---|---|
| Pentachlorophenol | Eye, nose and throat irritation; sneezing, coughing; weakness, anorexia, low-weight; sweating; headache, dizziness; nausea, vomiting; dyspnea, chest pain; high fever; dermatitis |
| Phenols | Eye, nose and throat irritant; anorexia, low-weight; weakness, muscle aches and pain; dark urine; cyanosis; liver and kidney damage; skin burns; dermatitis; ochronosis; tremor, convulsions, twitch |
| Silver (as dust and soluble compounds) | Blue-gray eyes; nasal septum, throat, skin irritation and ulceration; GI disturbance |
| 1,1,2,2-Tetra-chloroethylene (perchloroethylene) | Irritation of the eyes, nose, and throat, nausea; flush face and neck; vertigo dizziness, uncoordination; headache; somnolence; skin erythema; liver damage-carcinogen |
| Toluene | Fatigue, weakness; confusion, euphoria, dizziness, headache; dilated pupils, lacrimation; nervousness, muscle fatigue, insomnia; paresthesia, dermatitis |
| 1,1,1-Trichloroethane (methyl chloroform) | Headache, lassitude, CNS depression, poor equilibrium; eye irritation; dermatitis; cardiac arrhythmias |
| Trichloroethylene | Headache, vertigo; visual disturbance, tremors, somnolence, nausea, vomiting; eye irritation; dermatitis; cardiac arrhythmias, paresthesia |
| Trichlorofluoromethane (Fluorotrichloromethane) | Uncoordination, tremors; dermatitis; frost bite; cardiac arrhythmias, cardiac arrest |
| Vinyl Chloride | Weakness; abdominal pain, GI bleeding; hepatomegaly; pallor or cyanosis of extremities; carcinogen |

- A concentration above the limits of detection, for at least two rounds of sampling per location, for groundwater and surface water analyses.

- Any concentration above the limits of detection for sediment analyses.

Material Safety Data Sheets for these contaminants have been compiled and are included as Attachment C.

## 6.3 Physical Hazard Analysis

### 6.3.1 Confined Space Entry

It is not anticipated that there will be a need for a confined space entry procedure during the remedial investigation activities. However, should this condition occur, procedures for entering a confined space are outlined in Attachment D - Baker Safety SOPs.

### 6.3.2 Heat Stress

Monitoring

Provisions for monitoring for heat stress will be determined by the SHSO and performed as outlined below.

Heat stress monitoring is required for personnel wearing semipermeable or impermeable protective outerwear when there is an ambient air temperature greater than 70°F. One or more of the following procedures will be implemented:

1. Increased awareness of heat stress symptoms and buddy monitoring.
2. Fluid intake discipline.
3. Self monitoring of urine output quantities to prevent dehydration.
4. Work-rest intervals.

Calculate the Heat Exposure Threshold Limit Value (TLV) for work-rest intervals using the following steps:

1. Calculate the WBGT (Wet Bulb Globe Temperature) Index

$$WBGT = 0.7\,NWB + 0.2\,GT + 0.1\,DB$$

Where:

NWB = Natural wet bulb temperature
GT = Globe temperature
DB = Dry-bulb temperature

2. Estimate the metabolic work rate using the following guidelines:

   a. Light work (up to 200 Kcal/hr or 800 Btu/hr): e.g., sitting or standing to control machines, performing light hand or arm work.

   b. Moderate work (200 to 350 Kcal/hr or 800 to 1,400 Btu/hr): e.g., walking about with moderated lifting and pushing.

   c. Heavy work (350 to 500 Kcal/hr or 1,400 to 2,000 Btu/hr): e.g., pick and shovel work.

3. Evaluate the calculations against the following Heat Exposure TLVs.

| Work - Rest Regimen | Work Load | | |
|---|---|---|---|
| | Light | Moderate | Heavy |
| Continuous work | 30.0 (86) | 26.7 (80) | 25.0 (77) |
| 75% work - 25% rest, each hour | 30.6 (87) | 28.0 (82) | 25.9 (78) |
| 50% work - 50% rest, each hour | 31.4 (89) | 29.4 (85) | 27.9 (82) |
| 25% work - 75% rest, each hour | 32.2 (90) | 31.1 (88) | 30.0 (86) |

* For unacclimatized workers, the permissible heat exposure TLV should be reduced by 2.5°C.

4. Special considerations:

   a. An average of the time-weighted average (TWA) WBGT should be used if there is a difference between the environmental conditions of the work area and the rest area. This calculation is as follows:

$$\text{Average TWA WBGT} = \frac{\text{WBGT1} \times t1 \times \text{WBGT2} \times t2 + \ldots + \text{WBGTn} \times tn}{t1 + t2 + \ldots tn}$$

   b. Where exposure to hot environmental conditions is continuous for several hours or the entire work day, the TWA should be calculated as an hourly TWA, i.e., $t1 + t2 + \ldots tn = 60$ minutes. Where the exposure is intermittent, the TWA should be calculated as two-hour TWAs, i.e., $t1 + t2 + \ldots + tn = 120$ minutes.

   c. The TLVs for continuous work are applicable where there is a work-rest regimen of a five-day work week and an 8-hour work day with a short morning and afternoon break (approximately 30 minutes). Higher exposure values are permitted if additional resting time is allowed. All breaks, including unscheduled pauses and administrative or operational waiting periods during work, may be counted as rest time when additional rest allowance must be given because of high environmental temperatures.

   d. Other considerations include:

      - Clothing - Use the following correction factors for various Clo values (insulation values) of clothing. In Celsius subtract 2 for clothing with a Clo of 1.0; subtract 4 for clothing with a Clo of 1.4; and subtract 6 for clothing with a Clo value of 1.2.

      - Acclimatization - After approximately a week, workers should have acclimated themselves to their environment.

      - Fitness - Physically fit workers will adjust more readily to a change in environment.

- Medication - Some medications can predispose individuals to heat-induced illnesses.

Causes and Symptoms

The following heat stress causes and symptoms are provided for buddy monitoring purposes. Site personnel must realize that monitoring the physical condition of fellow personnel in Level B and C protective ensembles will be difficult.

1. *Heat rash* results from continuous exposure to heat or humid air.

2. *Heat cramps* are caused by heavy sweating and inadequate fluid intake. Symptoms include muscle spasms and pain in the hands, feet, and abdomen.

3. *Heat exhaustion* occurs when body organs attempt to keep the body cool, due to inadequate fluid intake and personnel not acclimated to the environment. Symptoms include pale, cool, moist skin; heavy sweating; and dizziness.

4. *Heat stroke* is the most serious form of heat stress. It is a MEDICAL EMERGENCY. Symptoms are red, hot, dry skin; lack of perspiration; nausea; dizziness and confusion; strong, rapid pulse rate; and coma.

The need to seek medical attention and the urgency in seeking medical attention depends on the symptoms and the severity of the symptoms displayed by the affected individual. If *heat stroke* is noted or suspected, medical attention must be sought IMMEDIATELY. Efforts should be taken to cool the body to prevent serious injury or death. Excessive cooling can cause hypothermia and should be avoided.

Prevention

Fluid intake should be increased during rest schedules to prevent dehydration. Drinking cool water is best; however, diluted electrolyte solutions (i.e., Gatorade or equivalent) can be substituted for water. Each individual should monitor their urine output and adjust their fluid intake to ensure that urine output and urine color are close to normal. Additional means for preventing heat-induced illnesses may include providing shelter or cooling devices, such as vests and showers.

### 6.3.3 Explosion and Fire

In general, the following items present potential physical hazards and will be monitored closely:

- Explosion and fire resulting from heavy equipment malfunction.
- Explosion and fire resulting from penetration into underground utility lines (gas, electric).
- Explosion and fire resulting from ignition of trapped flammable vapors.
- Explosion and fire resulting from vehicular accidents.

As additional concerns are identified, provisions for making changes to the HASP will be presented by the SHSO, as needed.

### 6.3.4 Site-Specific Safety Considerations

The following safety considerations have been addressed at the Camp Allen Landfill Site:

- Although additional categories of hazardous materials (i.e. caustics, acids, asbestos, paints, paint thinners, etc.) have been identified as being buried at this site, only those chemicals meeting the criteria discussed in Section 6.2.2 have been identified. The likelihood of encountering "intact" materials (versus degradation materials) through the limited amount of intrusive work to be performed on the landfill, was considered to be immeasurable when evaluating potential hazards. Levels of protection are based on these assumptions. Therefore, only those chemicals previously detected have been further evaluated.

- Special consideration will be given to the Brig Facility located within Area A during any RI Activities performed in or around the facility. The Site Manager will be responsible for notifying the Brig Duty Officer (BDO) prior to initiating activities. For work inside the Brig fence, the Site Manager will notify the BDO at least 24 hours prior to start of work to arrange for an escort. The Site Manager will be made aware of the Brig evacuation procedures prior to initiating any intrusive activities. Additionally, the BDO will be instructed to close all windows and doors during

intrusive activities that occur upwind. Personnel will be instructed to adhere to all zone requirements as outlined in Section 5.0.

Provisions for the monitoring of hazards particular to the specific site activities (such as slippery ground, uneven terrain, overhead equipment, electrical lines, etc.) shall be addressed at the pre-entry briefing by the SHSO or qualified designee. All personnel are expected to adhere to all applicable safety regulations in OSHA standards, 29 CFR 1910 and 1926, and follow good safety practice as described in this HASP.

## 6.4 Radiation Hazard Analysis

Although the potential for radiological waste disposal at the Camp Allen Landfill is low, radiation monitoring will be required to determine the presence or absence of gamma rays, or alpha and beta particles as a standard operating procedure (Section 7.2 identifies the monitoring requirements).

A brief discussion of the different types of ionizing radiation follows:

Alpha particles, because of their relatively large mass, have the highest ionizing potential but the lowest penetrating quality of all forms of ionizing radiation. Alpha particles travel no more than 10 centimeters in air and can be shielded completely with paper. Adverse health affects from alpha particles are caused by absorption via inhalation, ingestion, or a break in the skin.

Beta particles have a lower ionizing potential than alpha particles but are more penetrating. Beta particles can be shielded with aluminum or Lucite. They can be absorbed into the human body via inhalation, ingestion, or skin penetration.

Gamma rays are the most penetrating form of ionizing radiation. Shielding can reduce gamma rays but not completely eliminate them. They can be absorbed via inhalation and ingestion of radioactive material, or can penetrate intact skin.

Protection from exposure to the alpha and low energy beta particles, will be accomplished by site workers wearing Levels B and C protection. Monitoring at the work site with a radiation survey meter will determine gamma ray and high energy beta particle exposure rates and serve as the indicator for leaving the area. If the monitoring shows a level higher than 1

mr/hr, work will stop and not resume until the SHSO has been notified, additional protective measures are instituted, such as decreasing the time of exposure, increasing the distance from the source, and employing shielding measures.

## 7.0 SITE SAFETY AND HEALTH

### 7.1 Responsibilities

The SHSO, as identified in Section 2.0, is directly responsible for safety and health requirements on site.

### 7.2 Environmental Monitoring

The environmental monitoring instruments addressed in the following sections will be used on site at the specified intervals. Criteria for determining the type of equipment to be used and levels of protection were based on the following:

- The low concentrations (ppb and ppm) of the contaminants found within the different matrices (excluding concentrations found within the landfill proper, in which case, Level B protection has been assigned).
- The limited amount of intrusive work.
- The short duration of the work to be performed.
- The low potential for an inhalation hazard from volatilization of chemicals from either groundwater or surfacewater.
- The HEPA respiratory protection available (see Section 8.2) for potential particulate (i.e. metals, semi-volatiles) entrainment in the ambient environment that could occur during intrusive work.

#### 7.2.1 Point Source

Point source monitoring is defined by this HASP as monitoring performed at the source of the activity or within the breathing zone (bz) of the work party personnel; therefore, the tasks being performed at each site along with the type and frequency of monitoring required have been outlined in Table 3. The actions to be followed, given the concentration measured, are as follows:

## TABLE 3

## MONITORING EQUIPMENT AND FREQUENCY AT THE CAMP ALLEN LANDFILL SITE

| Area(s) | Job Task | PID[a] or FID[b] | Dräger Colorimetric Tubes[2] | | | Combustible Gas Meter | Radiation Survey Meter[1] |
|---|---|---|---|---|---|---|---|
| | | | (CH 27301) Methyl[3] Bromide | (67 28561) Benzene | (67 28031) Vinyl Chloride | | |
| A&B | Sediment/Surface Water Sampling | C | I&P | I&P | I&P | | I |
| A&B | Surveying | C | | | | | |
| A&B | Non-Intrusive Geophysics | C | | | | | |
| B | Surface Soil Sampling (off site) | C | | | | | I&P |
| A&B | Monitoring Well Installation | C | I&P[4] | I&P[4] | I&P[4] | C | C |
| A&B | Groundwater Sampling | C | P | P | P | | I&P |
| A&B | Slug Test | C | P | P | P | | I&P |
| A | Geologic Borings | C | I&P | I&P | I&P | C | C |
| A | Residential Well Sampling (off site) | I&P | | | | | |
| A&B | Soil Boring-Sampling | C | P | P | P | C | C |
| A | Aquifer Design Testing | C | | | | | C |

I = Initially - At start of job task to confirm level of respiratory protection.
P = Periodically - When site condition or set-up changes, or when a new area is entered.
C = Continuously - Monitor levels continuously.

(a) PID = Photoionization Detector
(b) FID = Flame Ionization Detector

Note: As air concentrations are measured, they will be documented. In the case of continuous monitoring, every 15 to 30 minutes.

(1) The Victoreen Model 450 Radiation Survey Meter measures gamma radiation and detects the presence of beta and alpha particles when the mylar screen is exposed. Alpha particle detection is possible only when the mylar screen is very close (<3 mm) to the surface being tested. The meter must be placed at the survey location and held there until the instrument responds.

(2) The exact Dräger tubes to be used at this site are subject to change, based on site concerns.

(3) For indicting 1,2-Dichloroethane (ethylene dichloride)

(4) During Level C activities.

*PID or FID

- Background to 1 ppm = Level D
- >1 ppm to 5 ppm for greater than 5 continuous minutes = Level C plus colorimetric tube monitoring
- >5 ppm for up to 15 continuous minutes = Level B or Stop Work
- Instantaneous concentrations >50 ppm = Level B or Stop Work

* PID with 10.2 eV or 11.7 eV ultraviolet lamp for non-intrusive and intrusive activities, respectively.
FID will be used for all intrusive work within the boundaries of the landfill.

Dräger Tubes (used to determine if Level C or D+ protection levels are adequate for highly volatile constituents, with an EL ≤10 ppm)

- Below limits of detection (BLD) to less than the EL (Exposure Level)* = Level D
- ≥EL to 5 times the EL = Level C (if adequate NIOSH certified air-purifying cartridge is available -- otherwise Level B or Stop Work)
- >5 times the EL = Level B or Stop Work

*Refer to Table 1 , Section 6.2, for explanation.

Combustible Gas Meter*

- <10% of the Lower Explosive Limit (LEL) = continue working
- 10% to 20% of the LEL = continue work with extreme caution and use non-sparking tools (if applicable)
- >20% of the LEL = stop work immediately

*Used to evaluate physical safety in conjunction with PID/FID/Dräger Tubes

Radiation Survey Meter (Victoreen Model 450)

- Background (0.02 to 0.04 mr/hr) = Level D
- Background to 1 mr/hr = Level B or C
- 1 mr/hr to 2 mr/hr = Leave area and consult SHSO

### 7.2.2 Perimeter Monitoring

Perimeter monitoring is defined as monitoring performed at borders beyond the Support Zone and often at the "fence line." Releases occurring during these types of RI/FS activities are expected to be minimal. Therefore, it is anticipated that the type and frequency of monitoring required for each site will be as follows:

- The PID/FID will be used periodically to scan the perimeter as a means of documenting any volatile releases that may extend past the work zone, when volatiles are detected at the point source.

- Dräger Colorimetric Tubes will be used periodically to measure any potential releases when contamination is detected at the point source. Refer to Table 3 to determine the specific tubes required for each task.

- The Radiation Survey Meter will be used to determine the boundaries of radioactivity, if radiation is detected at the point source.

It is not anticipated that there will be a need for any additional monitoring. However, as work progresses, additions to the scope of monitoring will be investigated by the SHSO.

### 7.2.3 Monitoring Documentation

As environmental monitoring is performed, documentation of the results will be entered into the Field Log Book of the SHSO or other personnel performing the monitoring. At the end of each day, these values will be entered onto an air monitoring log sheet. The log sheets will be placed in a binder and remain on site till the end of the field activities, whereby the log sheets will become part of the permanent file. A complete copy of the log sheets will also be filed with the Project Health and Safety Officer.

## 7.3 Personal Monitoring

The following personal monitoring will be in effect on site.

Breathing Zone monitoring for organic volatiles (and some inorganic volatiles), as outlined in Section 7.2.1, should be sufficient according to the work activities, and hazard evaluation presented in Section 7.2. However, as work progresses, additions to the scope of monitoring may be extended based on monitoring results, odor detection, changing work conditions, and signs or symptoms of exposure. Any or all of these conditions will be immediately investigated and acted upon by the SHSO.

## 7.4 Equipment Maintenance and Calibration

Baker's procedures for the return of equipment to inventory and for maintenance of the equipment shall be followed in order to assure that the optimum level of operation is maintained for the item. Personnel using equipment shall complete a field equipment usage

form which will be reviewed by the PHSO. Equipment calibration by the SHSO will be completed at the beginning of each day at a minimum, and entered into the equipment calibration log. Additional calibration may be required throughout the day, as environmental and equipment conditions change. Procedures for equipment maintenance and calibration are based on manufacturer's recommendations. Refer to Baker's Standard Operating Procedures for Administrative, Field, and Technical Activities Manual.

## 8.0 PERSONAL PROTECTIVE EQUIPMENT

### 8.1 Levels of Protection

Based on an evaluation of potential hazards (see Section 7.2), the following levels of personal protection have been designated for the applicable work areas and tasks. Upgrading or downgrading the level of protection will be based on real time monitoring (as outlined in Section 7.2.1), and working conditions. Changes in Level of Protection will be the responsibility of the SHSO.

| Camp Allen Landfill Areas | Job Task | Level of Protection[1] | | | |
|---|---|---|---|---|---|
| | | B | C | D+ | D |
| A & B | Sediment/Surface Water Sampling | | | X | |
| A&B | Surveying | | | | X |
| A&B | Non-intrusive Geophysics | | | | X |
| B (off-site) | Surface Soil Sampling | | | | X[2] |
| A&B | Monitoring Well Installation[3] | X | X | X | |
| A&B | Groundwater Sampling | | | X | |
| A&B | Slug Test | | | X | |
| A | Geologic Borings | X | | | |
| A (offsite) | Residential Well Sampling | | | | X[2] |
| A&B | Soil Boring - Sampling | X | | | |
| A | Aquifer Design Testing | | | X | |

(1) The "Buddy System" will effect at all times during Level B, C, and D+ Activities.
(2) Standard work uniform with gloves.
(3) Level C except for stainless steel well (B-20 WSS) which will be drilled and installed initially in Level B PPE. All other well installations will be conducted in Level C or D+ protection, unless an upgrade in protection is required based on elevated field measurements and/or observations.

Monitoring in the breathing zone with a PID/FID and intermittent monitoring with Colorimetric (Dräger) Tubes as outlined in Section 7.2.1 (Table 3) will be conducted to evaluate these levels of protection.

Specific protective equipment for each level of protection is as follows:

| Level B | Level C |
|---|---|
| Chemical Resistant Clothing (1) | Chemical Resistant Clothing/Coveralls (1) |
| Air Line Respirator (ALR) with 5 minute escape pack | Full-face cartridge respirator |
| Self-Contained Breathing Apparatus (SCBA) for Rescue | Full-face cartridge respirator |
| Chemical-resistant Gloves (Inner - Disposable) | Chemical-resistant Gloves (Inner - Disposable) |
| Chemical-resistant Gloves (Outer) | Chemical-resistant Gloves (Outer) |
| Safety Shoes/Boots | Hearing Protection (Optional)* |
| Boots (Chemical Resistant - Overboots) | Safety Shoes/Boots |
| Hard Hat | Boots (Chemical Resistant - Overboots) |
| | Hard Hat |
| Hearing Protection (Required) | |

| Level D+ | Level D |
|---|---|
| Chemical Resistant Clothing/Coveralls (1) | Normal Work Clothes or Coveralls |
| Gloves (Inner-Disposable) | Safety Shoes/Boots |
| Gloves (Outer) | Chemical Protective Overboots |
| Hearing Protection (Optional)* | Hard Hat |
| Safety Shoes/Boots | Gloves (Outer) |
| Boots (Chemical Resistant - Overboots) | Hearing Protection (Optional)* |
| Hard Hat | Safety Glasses/Goggles |
| Safety Glasses/Goggles | |
| Full-face Cartridge Respirator (on standby) | |

* The need for hearing protection will be determined by the SHSO.
(1) Polyethylene-coated Tyvek or Saranex.

CHANGES TO THE SPECIFIED LEVELS OF PROTECTION SHALL ONLY BE MADE WITH THE APPROVAL OF THE SITE HEALTH AND SAFETY OFFICER AND THE SITE MANAGER.

## 8.2 Respiratory Protection

Level B

- A combination (4-person manifold) "North" Brand Air Line Respirator (ALR) System with 5-minute escape pack. The line of site worker will be equipped with a "North" Brand Self-Contained Breathing Apparatus (SCBA) in addition to the ALR System for emergency rescue purposes. This individual will also be responsible for monitoring the supplied air system.

Level C

- A "North" or "MSA" Brand full-face NIOSH certified air-purifying organic vapor acid gases/HEPA filter cartridge respirator is the appropriate cartridge for use with the detected hazardous materials and the measured air contaminant concentrations. Upgrade/downgrade in the level of respiratory protection will be based on measured "realtime" air contaminant concentrations (see section 7.2), odor breakthrough, irritation, and/or other pertinent warning properties. Cartridge changeover or protection upgrade will occur when one or more of the following conditions have been observed: PID/FID concentrations greater than or equal to 100 ppm for vapor/gas cartridges; exposure duration greater than eight hours for vapor/gas cartridges; breathing resistance due to overloaded particulate filters; odor breakthrough due to overloaded vapor/gas cartridges; and other warning properties, where appropriate, for specialty filter cartridges.

Level D+

- A NIOSH certified air-purifying cartridge respirator meeting all the requirements identified under Level C, on standby.

Criteria for using this type of respiratory protection has been determined by qualified Baker personnel in compliance with Attachment D - Baker Safety SOPs.

## 8.3 Care and Cleaning of Personal Protective Equipment

Provisions for the care and cleaning of personal protective equipment used on site can be found in Attachment D - Baker Safety SOPs. Responsibility for compliance with these provisions lies with the Site Manager.

## 9.0 DECONTAMINATION PROCEDURES

### 9.1 Site Decontamination

Personnel and equipment leaving the Exclusion Zone (Work Zone) shall be thoroughly decontaminated while exiting through the decontamination corridor. The following protocol shall be used for the decontamination stations according to levels of protection:

| Level D | Level D+ | Level C | Level B |
|---|---|---|---|
| 1. Equipment drop | 1. Equipment drop | 1. Equipment drop | 1. Equipment drop |
| 2. Boot and glove gross contamination removal* | 2. Outer boot and glove wash | 2. Outer boot and glove wash | 2. Outer boot and glove wash |
| 3. Boot and glove wash* | 3. Outer boot and glove rinse | 3. Outer boot and glove rinse | 3. Outer boot and glove rinse |
| 4. Boot and glove rinse* | 4. Outer boot and glove removal | 4. Outer boot and glove removal | 4. Outer boot and glove removal |
| 5. Boot and glove removal* | 5. Coverall removal/disposal | 5. Coverall removal/disposal | 5. SCBA or escape tank removal |
| 6. Coverall removal* | 6. Inner glove removal/disposal | 6. Respirator removal | 6. Coverall removal/disposal |
| 7. Hand/Face wash | 7. Hand/face wash | 7. Inner glove removal/disposal | 7. SCBA or ALR face piece removal |
| 8. Equipment wipe down | 8. Equipment cleaning | 8. Hand/face wash | 8. Inner glove removal/disposal |
| | | 9. Respirator cleaning/sanitizing | 9. Hand/face wash |
| | | 10. Equipment cleaning | 10. Respiratory cleaning/sanitizing |
| | | | 11. Equipment cleaning |

*Optional - depends on degree of contamination and type of PPE used.

The following decontamination equipment is required for Level D+ and higher protection levels and recommended for Level D protection:

- Four small tubs (two sets of wash and rinse water)
- Scrub brush
- Towels
- Contaminated clothing disposal bag or drum
- Respirator cleaning solution
- Alconox and water for the decontamination solution

The decontamination liquids and clothing will be contained and disposed according to the policy defined in the Sampling and Analysis Plan (SAP).

## 9.2 Emergency Decontamination

Emergency personnel decontamination will include the following stations*:

| Level D | Level D+ | Level C | Level B |
|---|---|---|---|
| 1, 5, and 6 as referenced above | 1, 4, 5, and 6 as referenced above | 1, 4, 5, 6, and 7 as referenced above | 1, 4, 5, 6, 7, and 8 as referenced above |

* If circumstances dictate that contaminated clothing cannot be readily removed, then remove gross contamination, wrap injured personnel with clean garments/blankets, to avoid contaminating other personnel or transporting equipment.

  All emergency personnel are to be immediately informed of the injured person's condition, potential contaminants, and provided with all pertinent chemical data.

## 9.3 Equipment Decontamination

Provisions for the decontamination of equipment will be based on the size and type of equipment used. Specific decontamination procedures for the Camp Allen Landfill Site can be found in the SAP.

## 10.0 COMMUNICATION PROCEDURES

The "Buddy System" (teams of at least two persons) will be employed during all Level B, C, and D+ site activities. Personnel in the Exclusion Zone (Work Zone) should remain in constant communication or within sight of the Site Manager, or his/her representative. Any failure of communication requires an evaluation of whether personnel should leave the Exclusion Zone.

**Air horns will be used for communication during emergency evacuation of site personnel. One long (3 second) air horn blast is the emergency signal to indicate that all personnel should evacuate the Exclusion Zone.**

The following standard hand signals will be used in case of failure of radio communications or when radio communications are not available:

| | | |
|---|---|---|
| Hand gripping throat | - | Out of air, can't breathe |
| Grip partner's wrist or both hands around waist | - | Leave area immediately |
| Hands on top of head | - | Need assistance |
| Thumbs up | - | OK, I am all right, I understand |
| Thumbs down | - | No, negative |

The following audible signals, using a hand-held air horn, will be implemented in the event of radio communications failure, when verbal or hand signals are not feasible or if immediate notification of project personnel is needed:

**1-long = Evacuate or All's Clear(1)**
**1-short = Attention Getter(2)**
**2-short = Fire**
**3-short = Emergency/Need Help**

(1) Long = 3-second blast
(2) Short = 1-second blast intervals

Coordination between Baker and Contractor Personnel is the responsibility of the Field Team Leader. The best means for securing the lines of communication will be determined prior to start-up by on-site project personnel.

Telephone communication will be established at the Command Post (Baker Site Trailer). The mobile telephone number is (access code) + (412) 298-3553.

## 11.0 EMERGENCY PROCEDURES

### 11.1 Pre-Emergency Planning

All emergency response contacts at Camp Allen will be notified prior to initiating RI activities in or around the facility. Notification will be performed by the SHSO and include the base BDO, On-Scene Coordinator, Fire Department, Security, Ambulance, Hazardous Materials Team, and Emergency Center.

### 11.2 Emergency Coordinator

The SHSO acting as the Emergency Coordinator is responsible for field implementation of the Emergency Plan. As the Emergency Coordinator, specific duties include:

- Communicating site emergency procedures and requirements to all Baker and subcontractor personnel.
- Specifying a backup/alternate Emergency Coordinator.
- Controlling activities of subcontractors and contacting base response groups and outside agencies.
- Anticipating, identifying, assessing, and controlling fires, explosions, chemical releases, and other emergency situations.

All on-site personnel, whether involved in emergency response or not, will be notified of their responsibilities by the Emergency Coordinator in an emergency. They will be familiar with the emergency procedures and the Emergency Coordinator's authority.

### 11.3 Communications

The primary internal communication system will rely on direct communications between site personnel. External communications will employ a telephone located in the site trailer. Refer to section 10.0 for an outline of the Communication Procedures.

Emergency telephone numbers will be place at strategic locations throughout the site. The list of emergency phone numbers is presented below.

| Facility | Phone Number On-Base | Phone Number Off-Base |
|---|---|---|
| Security | (4) 8751 | (804) 444-8751 |
| Fire | (4) 3333 | (804) 444-3333 |
| Ambulance (Sewell Point) | (4) 2674 | (804) 444-2674 |
| Hospital (DePaul General) | (9) 489-5111 | (804) 484-5111 |
| Brig (Brig Duty Officer) | (4) 5601 or 5511 | (804) 444-5601 |
| Emergency (One Call) | (4) 0716 or 0720 | 911 |
| Hazardous Waste Dispatcher | (4) 7528 | (804) 444-7528 |
| On-Scene Coordinator | (5) 8851 | (804) 445-8851 |
| Public Works | (4) 8670 | (804) 444-8670 |
| Poison Control Center | (9) 722-1131 | (804) 722-1131 |
| NRC | (9) 800-424-8802 | (800) 424-8802 |
| MISS Utility | (9) 800-552-7001 | (800) 552-7001 |

## 11.4 Assembly Area

In the event of an emergency personnel will be instructed to meet at the site trailer. If possible, personnel will exit the work area through the decontamination zone. If the trailer is inappropriate a site evacuation area will be designated by the Emergency Coordinator in an upwind location from the site before the start of operations. At this location, emergency needs will be provided, such as:

- Assembly for evacuated personnel
- First aid for injured personnel
- Decontamination material
- Communications.

## 11.5 Emergency Services Map

An emergency services route map showing the location of the local hospital will be posted. Personnel will be informed of the map and directions to the hospital.

Directions to DePaul General Hospital follow (Refer to Figure 3):

1. From Area A or B proceed west on Ingersol Street until arriving at a "T", then turn right and a quick left onto Helmick Street.

2. Proceed on Helmick Street until intersecting with Hampton Boulevard (Route 337), then turn left and proceed south on Route 337 until intersecting with Little Creek Road.

3. Turn left onto Little Creek Road and proceed east for approximately 2-1/4 miles until intersecting with Granby Street, then turn right (south).

4. Continue on Granby Street until intersecting with Kingsley Lane (approximately 1 1/2 miles) and DePaul General Hospital will be on right-hand side.

Site Address: Baker Site Trailer
B Street (Adjacent to Salvage Yard)
Camp Allen
Norfolk, Virginia 23511

Site Telephone Number: (access code) + (412) 248-3553

## 11.6 Emergency Medical Treatment

The nearest public hospital is DePaul General located at the intersection of Granby Street and Kingsley Avenue, phone no.: (804) 489-5111 off base and (9) 489-5111 on base. See Section 7.5.3 for directions and map of route to DePaul General Hospital.

Note: In emergencies, personnel may be transported to The Sewell Point Clinic (Naval Clinic) for initial treatment.

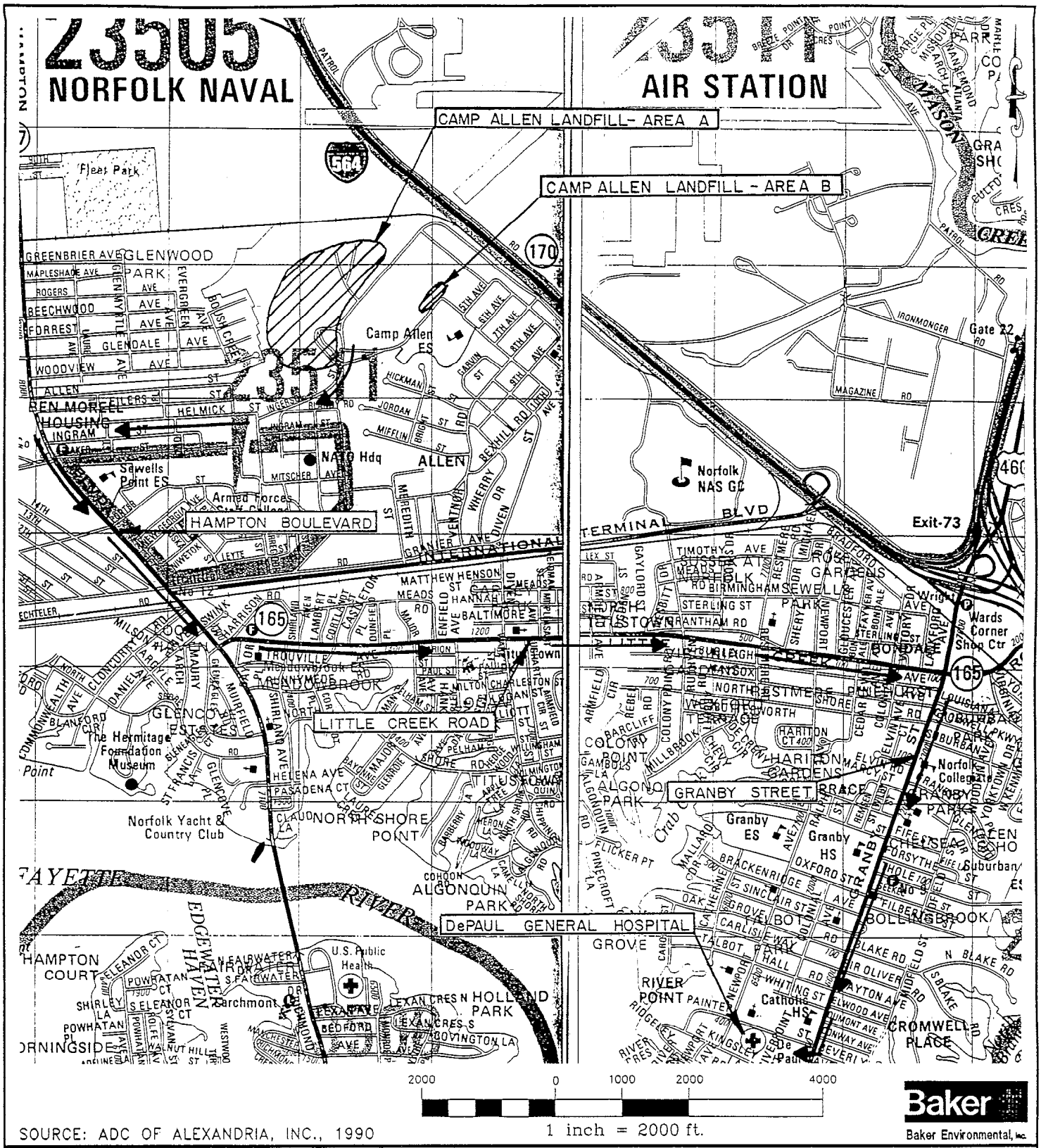


FIGURE 3
EMERGENCY HOSPITAL ROUTE
CAMP ALLEN LANDFILL
AREAS A and B
NORFOLK NAVAL BASE
NORFOLK, VIRGINIA

Local ambulance service is available from the Sewell Point Clinic and can be reached at (4) 2674 on base or (804) 444-2674 off base. Contact should be made with emergency personnel prior to the start of activities, including providing the emergency medical facilities with Material Safety Data Sheets for contaminants detected at the site.

If an employee working in a contaminated area is physically injured, first-aid procedures are to be followed. Depending on the severity of the injury, emergency medical response from base personnel may be sought. If the employee can be moved, he/she will be taken to the edge of the work area, decontaminated(refer to section 9.2) if circumstances permit, administered emergency first aid, and transported to an awaiting ambulance or local emergency medical facility.

If the injury to a worker is chemical in nature (e.g., overexposure), the following first-aid procedures are to be instituted:

- Eye Exposure - If contaminated solid or liquid gets into the eyes, wash the eyes immediately at the emergency eyewash station using large amounts of water and lifting the lower and upper lids occasionally. Obtain medical attention immediately. Contact lenses will not be worn when working.

- Skin Exposure - If contaminated solid or liquid gets on the skin, promptly wash the contaminated skin using soap or mild detergent and water. If solids or liquids penetrate through the clothing, remove the clothing immediately and wash the skin using soap or mild detergent and water. Obtain medical attention immediately.

- Swallowing - If contaminated solid or liquid has been swallowed immediately contact the poison control center. Do not make an unconscious person vomit. If signs of overexposure develop contact the Virginia Peninsula Poison Control Center at (804) 722-1131.

- Breathing - If a person has difficulty breathing, move the exposed person to fresh air at once. If breathing has stopped, perform artificial respiration. Keep the affected person warm and at rest. Obtain medical attention as soon as possible.

If injuries are not serious or life threatening, affected personnel may be transported by other site personnel to the local medical facility, if necessary. Emergency medical response

personnel will be contacted in the event of serious or multiple injuries. Medical personnel will be provided with all available information regarding the nature of the incident and chemicals involved.

If on-site decontamination of injured employee(s) is not possible, the Emergency Coordinator will provide polyethylene sheeting for a stretcher, and ambulance. If necessary, a site employee equipped with appropriate protective equipment and clothing will accompany the injured employee and will perform decontamination under the supervision of emergency medical personnel.

Instances requiring treatment beyond "first aid" will be handled at appropriate facilities and reported to the Project Manager and PHSO within 24 hours.

## 11.7 Emergency Decontamination Procedures

In the event of a medical emergency, patients are to be adequately decontaminated before transfer, if possible. This is to prevent contamination of the medical transport vehicle and medical facility.

At a minimum, the patient should have the following removed before transport:

- Protective outer clothing
- Protective boots
- Protective gloves
- Other protective equipment.

If necessary, one of the site personnel equipped with appropriate PPE may accompany the injured worker and perform decontamination with supervision of medical personnel.

## 11.8 Personal Protection and First-Aid Equipment

PPE available for emergency response will include the following:

- Polyvinyl chloride boots
- Saranex® suits
- Tyvek® suits, polyethylene coated and uncoated

- Nitrile gloves
- Face shields and goggles
- SCBA
- Full-face air-purifying respirators.

PPE, first-aid equipment and the first-aid kits will be available in the support zone.

Emergency and first aid equipment can be found at the following locations:

| | |
|---|---|
| Fire Extinguisher: | "Hotline" and Baker Field Vehicle |
| First aid kit: | Baker Site Trailer and Baker Field Vehicle |
| Emergency eye wash bottle: | Baker Site Trailer and Baker Field Vehicle |
| Air Horn: | With Personnel |
| Emergency Eye Wash Station: | Near Area With Greatest Potential for Chemical Splash/Exposure |

## 11.9 Notification

If the Emergency Coordinator determines that the site has an uncontrolled situation, such as a spill, fire, or explosion, that could threaten health or the environment, he will report his findings as follows:

- Navy Emergency Center
- Navy On-Scene Coordinator
- BDO
- Navy Security
- Hospital (as necessary)

The notification report will be made from the site office to the appropriate support groups and will include:

- Description of incident (e.g., release, fire).
- Name and telephone number of reporter.
- Name and address of incident.
- Name and quantity of materials or material involved.
- The extent of injuries.

- The possible hazards to human health or the environment and cleanup procedures.
- Assistance that is requested.

## 11.10 Hazard Assessment

The Emergency Coordinator will assess possible hazards to human health or the environment that may result from a chemical release, fire, explosion, or severe weather conditions. The Emergency Coordinator will assess the hazards posed by an incident through the following steps, as appropriate:

- Assess the immediate need to protect human health and safety.
- Identify the materials involved in the incident.
- Identify exposure and/or release pathways and the quantities of materials involved.
- Determine the potential effects of the exposure/release and appropriate safety precautions.
- Determine if release of materials meets EPA requirements for reportable quantities for spills under the RCRA or the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

This assessment will consider both the direct and indirect effects of the chemical release, fire, explosion, or severe weather conditions (e.g., the effects of any toxic, irritating, or asphyxiating gases that are generated or the effects of any hazardous surface water runoff from water or chemical agents used to control fire and heat-induced explosions).

## 11.11 Security

During activation of the Emergency Plan, the Emergency Coordinator or his designated representative will control access to the site and maintain a security incident log that will include:

- Time of entry.
- Expected exit time.

- Use of team or "buddy" system.
- Task being performed.
- Location of task.
- Rescue and response equipment used.
- Protective equipment being used.

## 11.12 Emergency Alerting

**Personnel Injury in the Exclusion Zone**: Upon notification of an injury in the Exclusion Zone, the designated emergency signal (verbal) warning or three short airhorn blasts shall be sounded. All site personnel shall assemble at the decontamination control line (for Level D) or the CRZ (for Level D+ or higher). The rescue team will enter the Exclusion Zone (if required) to remove the injured person to the hotline. The SHSO and/or Site Manager will evaluate the nature of the injury, and assure that the affected person is decontaminated according to Section 9.2. If required, contact will be made with an ambulance, and/or with the designated medical facility. No persons shall reenter the Exclusion Zone until an accident investigation is performed by the SHSO and/or the Site Manager.

**Personnel Injury in the Support Zone**: Upon notification of any injury in the Support Zone, the Site Manager and SHSO will assess the nature of the injury. If the cause of the injury or loss of the injured person does not affect the performance of other site personnel, operations may continue. If the injury increases the risk to others, the designated emergency signal (verbal) warning or three short airhorn blasts shall be sounded and all remaining site personnel will move to the support zone for further instructions. Activities on site will stop until the added risk is mitigated.

**Fire/Explosion**: Upon notification of a fire or explosion on site, the designated emergency signal (verbal) warning or two short airhorn blasts shall be sounded and all site personnel will assemble at the contamination control line (for Level D) or the CRZ (for Level D+ or higher). The fire and police/security departments will be alerted and all personnel will move to a safe distance from the involved area for further instructions. Activities will stop until the added risk is mitigated.

**Personal Protective Equipment Failure**: If any site worker experiences difficulty, failure or alteration of protective equipment that affects the protection factor, that person and his/her buddy shall immediately cease work activities, leave the Exclusion Zone, and repair or replace

the defective equipment. Reentry will not be permitted until the equipment has been repaired or replaced.

**Other Equipment Failure**: If any other equipment on site fails to operate properly, the Site Manager and/or the Field Team Leader and SHSO shall be notified to determine the effect of this failure on continuing operations on site. If the failure affects the safety of site personnel, work with the equipment will cease until the situation is evaluated and appropriate actions taken.

Accident/injury reports will be completed for any accidents no matter how minor the injury. All injuries resulting in treatment other than first aid will be reported to the Project Manager and PHSO within 24 hours. Records on equipment failure will also be completed.

In all situations, when an on-site emergency results in evacuation of the Exclusion Zone, personnel shall not reenter until:

1. The conditions resulting in the emergency have been corrected.
2. The hazards have been reassessed.
3. The HASP has been reviewed and, if appropriate, modified.
4. Site personnel have been briefed on any changes in the HASP.

### 11.13 Training

Site personnel will be informed of the details in the Emergency Plan during initial HASP training. The Emergency Plan will be rehearsed by site personnel at least monthly or when elements of the plan change.

## 12.0 WASTE HANDLING PROCEDURES

The protocols outlined in the SAP for the handling, packaging, storage, and disposal of contaminated materials must be followed to: (1) minimize the risk of off-site exposures that could endanger public health; and (2) limit the potential for liabilities associated with handling, containment, storage, and transportation of contaminated materials.

## 13.0 SPILL CONTAINMENT PROCEDURES

In the event that a spill of hazardous substances (gasoline, oil, etc.) occurs during the implementation of field activities, spill containment will be utilized to prevent the additional migration of contaminants through the site area. Specific spill containment procedures will be dependent on the type of materials spilled and the type of environment affected. Potential spill containment procedures may include diking with absorbent/adsorbent material/pads, then removal or containment of the contaminated materials. Spill contaminant materials will be located within close proximity to the storage area of the hazardous substances in a manner such that, the pathway remains accessible and free of obstructions. Appropriate Navy Activity personnel will be notified as soon as possible in the event of a spill.

## 14.0 DECLARATION OF HASP REVIEW

**All site personnel have read the above plan and are familiar with its provisions.**

| Function | Name* | Signature |
|---|---|---|
| Site Manager | Ms. Jeri Trageser | |
| | Mr. Thomas Artman | |
| Field Team Leader/ Project Geologist | Ms. Jeri Trageser | |
| Site Health and Safety Officer | Ms. Barbara Cummings | |
| | Mr. Peter Monday | |
| Site Geologist | Mr. Donald Shields | |
| | Mr. John Zimmerman | |
| | Mr. John Nist | |
| | Mr. Richard Aschenbrenner | |
| Environmental Scientist | Ms. Melissa Davidson | |
| | Mr. Peter Monday | |
| | Mr. Richard Dabal | |
| | Mr. Mark Kimes | |
| | Ms. Kimberly Harriz | |
| Drilling Contractor | | |
| | | |
| | | |
| Survey Contractor | | |
| | | |
| | | |
| Geophysics Contractor | Mr. Michael Nutting | |
| | Mr. Mark Blackey | |
| Geoprobe Contractor | | |
| | | |
| | | |

*Actual field team members are to be determined.

The work party(s) were briefed on the contents of this plan on _____

at _____ a.m./p.m.

HASP amendment briefings:

| Date | Time |
|---|---|
| | |
| | |

| Date | Time |
|---|---|
| | |
| | |

| Date | Time |
|---|---|
| | |
| | |

# Attachment A
# Medical Surveillance Testing Parameters

## ATTACHMENT A

## MEDICAL SURVEILLANCE TESTING PARAMETERS*

Group I - Individuals Rarely in the Field (< 10 days/year)

- Medical History and Physical
- Eye Exam
- EKG (for individuals over 30 yrs.)
- CBC with differential

Group II - Individuals Occasionally in the Field (10-30 days/year)

- Medical History and Physical
- Eye Exam
- EKG (for individuals over 30 yrs.)
- Chest X-ray (biannual)
- Pulmonary Function (spirometry)
- CBC with differential
- SMA 20 or 24 (liver enzyme scan)

Group III - Individuals Frequently in the Field (> 30 days/year)

- Medical History and Physical
- Eye Exam
- EKG (for individuals over 30 years)
- Audiogram
- Chest X-ray (biannual)
- Pulmonary Function (spirometry)
- CBC with differential
- SMA 20 or 24 (liver enzyme scan)
- Urinalysis (glucose scan)
- Specific Blood and Urine Tests (dependent on field exposure)
  - Lead
  - Mercury
  - Arsenic
  - Cadmium
  - Nickel
  - Zinc
  - Chromium
  - Volatile organics**
  - Extractable organics**
  - Phenols**

Group III with Asbestos - Individuals frequently in the Field and also associated with asbestos

- Group III testing with the Asbestos Medical Questionnaire

Group IV - Individuals associated with Asbestos

- Medical history and physical
- Chest X-ray
- Pulmonary Function (spirometry)
- Urinalysis
- Asbestos Medical Questionnaire

* All tests annual except as indicated. The attending physician has the right to expand the medical monitoring as he/she deems necessary.

** Rare and expensive - to be performed only for individuals identified by the attending physician as being chronically exposed to organic compounds.

# Attachment B
# OSHA Training History of Project Personnel

ATTACHMENT B

OSHA TRAINING HISTORY OF PROJECT PERSONNEL

| Personnel | Anticipated Site Activities Phase I | Training Status |
|---|---|---|
| Thomas Artman | • Project Manager/Site Manager | • 40-hr. training completed: 05/88<br>• Supervisory training: Yes<br>• 8-hr. refresher completed: 04/92<br>• First Aid/CPR Training: 11/91<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Barbara Cummings | • Project Health and Safety Officer | • 40-hr. training completed: 10/91<br>• Supervisory training: Yes<br>• 8-hr. refresher completed: NA<br>• First Aid/CPR Training: 11/91<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Jeri Trageser | • Site Manager/Field Team Leader/Project Geologist | • 40-hr. training completed: 11/87<br>• Supervisory training: Yes<br>• 8-hr. refresher completed: 04/92<br>• First Aid/CPR Training: 11/91<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Peter Monday | • Site Health and Safety Officer/Environmental Scientist | • 40-hr. training completed: 03/90<br>• Supervisory training: Yes<br>• 8-hr. refresher completed: 03/92<br>• First Aid/CPR Training: Yes<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Donald Shields | • Site Geologist | • 40-hr. training completed: 02/88<br>• Supervisory Training: Yes<br>• 8-hr. refresher completed: 03/92<br>• First Aid/CPR Training: No<br>• Medical surveillance: Yes<br>• Fit Test: 05/92 |
| John Zimmerman | • Site Geologist | • 40-hr. training completed: 03/92<br>• Supervisory Training: 03/92<br>• 8-hr. refresher completed: N/A<br>• First Aid/CPR Training: No<br>• Medical surveillance: Yes<br>• Fit Test: 05/92 |

ATTACHMENT B

## OSHA TRAINING HISTORY OF PROJECT PERSONNEL

| Personnel | Anticipated Site Activities Phase I | Training Status |
|---|---|---|
| Richard Aschenbrenner | • Site Geologist | ◦ 40-hr. training completed: 01/88<br>• Supervisory Training: Yes<br>• 8-hr. refresher scheduled: 04/92<br>• First Aid/CPR Training: No<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| John Nist | • Site Geologist | • 40-hr. training completed: 07/90<br>• Supervisory Training: N/A<br>• 8-hr. refresher completed: 09/91<br>• First Aid/CPR Training: 08/91<br>• Medical surveillance: Yes<br>• Fit Test: 04/92 |
| Richard Dabal | • Environmental Scientist | • 40-hr. training completed: 10/89<br>• Supervisory Training: Yes<br>• 8-hr. refresher completed: 03/92<br>• First Aid/CPR Training: 11/91<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Melissa Davidson | • Environmental Scientist | • 40-hr. training completed: 01/90<br>• Supervisory Training: Yes<br>• 8-hr. refresher completed: 04/92<br>• First Aid/CPR Training: No<br>• Medical surveillance: Yes<br>• Fit Test: 09/91 |
| Mark Kimes | • Environmental Scientist | • 40-hr. training completed: 07/91<br>• Supervisory Training: Yes<br>• 8-hr. refresher completed: NA<br>• First Aid/CPR Training: 11/91<br>• Medical surveillance: Yes<br>• Fit Test: 10/91 |
| Kimberly Harriz | • Environmental Scientist<br>• Site Geologist | • 40-hr. training completed: 06/87<br>• Supervisory Training: 8/88<br>• 8-hr. refresher completed: 12/91<br>• First Aid/CPR Training:<br>• Medical surveillance: Yes<br>• Fit Test: 04/92 |

# Attachment C
# Chemical Safety Data Sheets

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8854

*Material Safety Data Sheets Collection:*

**Sheet No. 296**
**Arsenic and Compounds**

Issued: 4/90

## Section 1. Material Identification 31

**Arsenic Description:** Obtained from flue dust of copper and lead smelters as white arsenic (arsenic trioxide). Reduction with charcoal and sublimation in an $N_2$ current yields pure arsenic. Metallic arsenic is used for hardening copper, lead, and alloys; as a doping agent in germanium and silicon solid-state products, special solders, and medicine; and to make gallium arsenide for dipoles and other electronic devices. Arsenic compounds are used in manufacturing certain types of glass; in textile printing, tanning, taxidermy, pharmaceuticals, insecticides and fungicides, pigment production, and antifouling paints; and to control sludge formation in lubricating oils. Arsenic trioxide is the source for 97% of all arsenic products.

**Other Designations:** CAS No. 7440-38-2; arsen; arsenic black; As; gray arsenic; metallic arsenic.

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 4
S 2
K- 0

Genium


HMIS
H 3
F 2
R 2
PPG*
* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Arsenic and soluble compounds, as As

**OSHA PEL**
8-hr TWA: 0.5 mg/m³,* 0.01 mg/m³†

**NIOSH REL, 1987**
Ceiling: 0.002 mg/m³

**ACGIH TLV, 1989-90**
TLV-TWA: 0.2 mg/m³

**Toxicity Data‡**
Man, oral, $TD_{Lo}$: 76 mg/kg administered intermittently over a 12-year period affects the liver (tumors) and blood (hemorrhage)
Man, oral: 7857 mg/kg administered over 55 years produces gastrointestinal (in the structure or function of the esophagus), blood (hemorrhage), and skin and appendage (dermatitis) changes
Rat, oral, $TC_{Lo}$: 605 µg/kg administered to a 35-week pregnant rat affects fertility (pre- and post-implantation mortality)

* Organic compounds.
† Inorganic compounds.
‡ See NIOSH, *RTECS* (CG0525000), for additional mutative, reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data*

**Boiling Point:** sublimes at 1134 °F/612 °C
**Melting Point:** 1497 °F/814 °C
**Vapor Pressure:** 1 mm at 702 °F/372 °C (sublimes)
**Atomic Weight:** 74.92
**Density:** 5.724 at 57 °F/14 °C
**Water Solubility:** Insoluble†

**Appearance and Odor:** A brittle, crystalline, silvery to black metalloid. Odorless.

* This data pertains to arsenic only.
† Arsenic is soluble in nitric acid ($HNO_3$).

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Use dry chemical, $CO_2$, water spray, or foam to fight fires.
**Unusual Fire or Explosion Hazards:** Flammable and slightly explosive in the form of dust when exposed to heat or flame.
**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Arsenic is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** Arsenic can react vigorously on contact with powerful oxidizers such as bromates, peroxides, chlorates, iodates, lithium, silver nitrate, potassium nitrate, potassium permanganate, and chromium (VI) oxide. This material is also incompatible with halogens, bromine azide, palladium, dirubidium acetylide, zinc, and platinum.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of arsenic and its compounds produces irritating or poisonous gases.

## Section 6. Health Hazard Data

**Carcinogenicity:** The IARC, NTP, and OSHA list arsenic as a human carcinogen (Group 1). This evaluation applies to arsenic and arsenic compounds as a whole, and not necessarily to all individual chemicals within the group. Studies report that both the trivalent and pentavalent compounds are strongly implicated as causes of skin, lung, and lymphatic cancers. Experimental studies have shown that arsenic has tumorigenic and teratogenic effects in laboratory animals.
**Summary of Risks:** Arsenic compounds are irritants of the skin, mucous membranes, and eyes. The moist mucous membranes are most sensitive to irritation. Prolonged contact results in local hyperemia (blood congestion) and later vesicular or pustular eruption. Epidermal carcinoma is a reported risk of exposure. Peripheral neuropathy (degenerative state of the nervous system) is common after acute or chronic arsenic poisoning. Symptoms include decreased sensation to touch, pinprick, and temperature; loss of vibration sense; and profound muscle weakness and wasting. Other complications of acute and chronic arsenic poisoning are encephalopathy (alterations of brain structure) and toxic delirium.
**Medical Conditions Aggravated by Long-Term Exposure:** Damage to the liver, nervous, and hematopoietic (responsible for the formation of blood or blood cells in the body) system may be permanent. Pulmonary and lymphatic cancer may also occur.
**Target Organs:** Liver, kidneys, skin, lungs, lymphatic system.
**Primary Entry Routes:** Inhalation, ingestion of dust and fumes, via skin absorption.
**Acute Effects:** Acute industrial intoxication is more likely to arise from inhalation of arsine. However, with corrosive arsenical vapors, conjunctivitis, eyelid edema, and even corneal erosion may result. Inhalation may result in nasal irritation with perforation of the septum, cough, chest pain, hoarseness, pharyngitis, and inflammation of the mouth. If ingested, metallic or garlic taste, intense thirst, nausea, vomiting, abdominal pain, diarrhea, and cardiovascular arrhythmias (heartbeat irregularities) may occur. Symptoms generally occur within 30 minutes, but may be delayed for several hours if ingested with food. Acute poisoning may result in acute hemolysis (breakdown of red blood cells).
**Chronic Effects:** Chronic symptoms include weight loss, hair loss, nausea, and diarrhea alternating with constipation, palmar and plantar hyperkeratoses (thickening of the corneous layer of skin on palms and soles of feet), and skin eruptions, and peripheral neuritis (inflammation of the nerves). Leukemia, bone marrow depression, or aplastic anemia (dysfunctioning of blood-forming organs) may occur after chronic exposure.
**FIRST AID**
**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
**Skin:** *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
**Inhalation:** Remove exposed person to fresh air and support breathing as needed.
**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Physician's Note:** If emesis is unsuccessful after two doses of Ipecac, consider gastric lavage. Monitor urine arsenic level. Alkalinization of urine may help prevent disposition of red cell breakdown products in renal tubular cells. If acute exposure is significant, maintain high urine output and monitor volume status, preferably with central venous pressure line. Abdominal X-rays should be done routinely for all ingestions. Chelation therapy with BAL, followed by n-penicillamine is recommended, but specific dosing guidelines are not clearly established.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel of spill, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and contact with skin and eyes. Use nonsparking tools. With a clean shovel, scoop material into a clean, dry container and cover. Absorb liquid material with sand or noncombustible inert material and place in disposal containers. Do not release to sewers, drains, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations***
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance† (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [† per Clean Water Act, Sec. 307(a); per Clean Air Act, Sec. 112]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations‡**
Air Contaminant (29 CFR 1910.1000, Subpart Z): Not listed

* Designations for arsenic only.
‡ Listed as arsenic organic compounds (as As).

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
**Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PELs, ACGIH TLVs, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in closed, properly labeled, containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and heat and ignition sources. Protect containers from physical damage.

**Engineering Controls:** Avoid inhalation or ingestion of dust and fumes, and skin or eye contact. Practice good personal hygiene and housekeeping procedures. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program with training, maintenance, inspection, and evaluation. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement and annual physical examination with emphasis on the skin, respiratory system, and blood.

**Transportation Data (49 CFR 172.101, .102)**

**DOT Shipping Name:** Arsenic, solid
**DOT Hazard Class:** Poison B
**ID No.:** UN1558
**DOT Label:** Poison
**DOT Packaging Requirements:** 173.366
**DOT Packaging Exceptions:** 173.364

**IMO Shipping Name:** Arsenic, metallic
**IMO Hazard Class:** 6.1
**IMO Label:** Poison
**IMDG Packaging Group:** II
**ID No.:** UN1558

*MSDS Collection* References: 7, 26, 38, 53, 73, 85, 87, 88, 89, 100, 103, 109, 123, 124, 126, 127, 130, 136, 138
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M4

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## Section 1. Material Identification 31

**Barium and Compounds Description:** Produced by reducing barium oxide with aluminum or silicon in a vacuum at high temperature. The minerals barite ($BaSO_4$) and witherite ($BaCO_3$) are the primary sources of barium. Used as lubricant for anode rotors in X-ray tubes; a deoxidizer for copper; an extender in paints; a loader for paper, soap, rubber, and linoleum; a carrier for radium; a fire extinguisher for uranium or plutonium fires; a rodenticide; a stabilizer and mold lubricant in the rubber and plastics industries; a flux for magnesium alloys; getter alloys in vacuum tubes; and in spark-plug alloys and Frary's metal. Important barium compounds include carbonate (ceramics, rodenticide), sulfate (pigment and filler), hydroxide (water treatment, ceramics), nitrate (pyrotechnics), chloride (chemicals), chromate (pigments), oxide (lubricants), and peroxide (bleach).

R 2
F 3
S 2
K 4

Genium


HMIS
H 2
F 2
R 4
PPG*
* Sec. 8

**Other Designations:** CAS No. 7440-39-3; Ba.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

## Section 2. Ingredients and Occupational Exposure Limits

Barium, ca 100%

**OSHA PEL**
8-hr TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

**NIOSH REL, 1987**
None established

**Toxicity Data***
None listed

**ACGIH TLV, 1989-90**
TLV-TWA: 0.5 mg/m³ (Barium, soluble compounds, as Ba)

* Monitor *RTECS* (CQ8370000), for additional future data.

## Section 3. Physical Data*

**Boiling Point:** 2984 °F/1640 °C
**Melting Point:** 1337 °F/725 °C
**Vapor Pressure:** 10 mm Hg at 1920 °F/1049 °C
**Molecular Weight:** 137.33 g/mol
**Specific Gravity ($H_2O$ = 1 at 39 °F/4 °C):** 3.51 at 68 °F/20 °C
**Water Solubility:** Insoluble

**Appearance and Odor:** A silver white metal that is slightly lustrous and somewhat malleable.
**Comment:** Barium has a distinctive property of absorbing gases.

* Physcial data are for barium only.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** *Do not* use water or foam. For small fires, use dry chemical, soda ash, lime, or sand. For large fires, withdraw from area and let fire burn.
**Unusual Fire or Explosion Hazards:** In the powder form, barium is flammable at room temperature. It is also explosive in the form of dust when exposed to heat, flame, or by chemical reaction. The chlorate, peroxide, and nitrate compounds are reactive and may present fire hazards in storage and use.
**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and fully encapsulating suit. Barium may ignite itself if exposed to air. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Barium is stable at room temperature under special storage and handling conditions (Sec. 9). If the free metal is exposed to air, an explosion hazard exists because hydrogen is liberated. Barium compounds are more stable than elemental barium. Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** Barium reacts violently with water, carbon tetrachloride, trichloroethylene, fluorotrichloromethane, and tetrachloroethylene. This material is incompatible with acids, trichloroethylene and water, trichlorotrifluoroethane, 1,1,2-trichloro trifluoro ethane, and flurotrichloroethane. Barium is extremely reactive and reacts readily with halogens and ammonia. Barium compounds are not as reactive as elemental barium. See MSDSs 40, 119, 132, 173, 181, and 251 for specific chemical incompatibilities.
**Conditions to Avoid:** Avoid heating barium in hydrogen to about 392 °F/200 °C since it reacts violently and forms barium hydride ($BaH_2$). An explosion hazard exists if the free metal is exposed to moist air or cold water because hydrogen is liberated.

## Section 6. Health Hazard Data

**Carcinogenicity:** Although the NTP, IARC, and OSHA do not list barium as a carcinogen, the IARC lists barium chromate (VI) as a carcinogen.
**Summary of Risks:** Barium presents mainly an explosion hazard. However, soluble compounds of barium by the oral route are highly toxic and the fatal dose of the chloride has been stated to be 0.8 to 0.9 g. Death may occur from a few hours to a few days. The soluble barium compounds exert a profound effect on skeletal, arterial, intestinal, bronchial, and particularly cardiac muscle. Effects on the hematopoietic system (responsible for the formation of blood or blood cells in the living body) and the cerebral cortex are also noted. Poisoning may also occur if the dust of soluble compounds is inhaled. Certain compounds of barium are irritants of the skin, eyes, and mucous membranes. Barium oxide and barium hydroxide, strongly alkaline in aqueous solution, cause severe skin irritation and burns of the eye. Inhalation of insoluble barium produces a benign pneumoconiosis (baritosis). The half-life of barium in bone has been estimated at 50 days.
**Medical Conditions Aggravated by Long-Term Exposure:** None reported.
**Target Organs:** Skin, eyes, mucous membranes, lung, heart.
**Primary Entry Routes:** Inhalation of dust or fume, ingestion, skin or eye contact.
**Acute Effects:** Systemic absorption from ingestion causes gastroenteritis (inflammation of the stomach lining and the intestines), slow pulse rate (heart may stop while contracting), muscle spasm, and hypokalemia (potassium deficiency in the blood). Inhalation causes coughing, bronchial irritation, and pneumoconiosis. Contact with soluble salts causes dermatitis, irritation of the eyes and mucous membranes, and burns. During radiological examination, intraperitoneal (in the abdomen) or intrathoracic (in the chest) barium sulfate contamination resulting from a complication rupture may cause a significant inflammatory response.
**Chronic Effects:** Although baritosis (caused by inhaling barium sulfate) produces nodular opacities on chest X-rays, there is no evidence of clinical illness or bodily dysfunction.
**FIRST AID**
**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.
**Skin:** *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.
**Inhalation:** Remove exposed person to fresh air and support breathing as needed.
**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce vomiting.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Physician's Note:** Consider using calcium gluconate for muscular spasms. Consider gastic lavage followed by saline catharsis if soluble barium compounds are ingested. Institute cardiac monitoring for all significant ingestions of soluble barium salts.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel of spill. Immediately shut off all heat and ignition sources and evacuate hazard area. Cleanup personnel should protect against dust inhalation and contact with skin, eyes, and mucous membranes. For small dry spills, use a clean shovel to place material into a clean, dry container with a cover. For a large dry spill, cover with a plastic sheet to minimize spreading. For liquid spills, cover with sand or other noncombustible material and place in disposal containers. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations***
RCRA Hazardous Waste (40 CFR 261.33): Not listed
CERCLA Hazardous Substance (40 CFR 302.4): Not listed
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations ***
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

*Designations for barium only.

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.
**Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store under inert gas, petroleum, or oxygen-free liquid in a cool, dry, well-ventilated area away from all incompatibles (Sec. 5).
**Engineering Controls:** Barium metal itself presents mainly an explosion hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Use nonsparking tools. Proper storage is essential. Avoid dust inhalation and skin, eye, and mucous membrane contact. All processes should be enclosed and/or exhaust ventilation installed to keep the dust concentrations below the recommended levels. Practice good personal hygiene and housekeeping procedures. Preemployment and periodic medical examinations should be given to workers exposed to barite dust. Prevent exposing individuals with respiratory disorders.

**Transportation Data (49 CFR 172.102)**
**IMO Shipping Name:** Barium alloys, pyrophoric
**IMO Hazard Class:** 4.2
**IMO Label:** Spontaneously combustible
**IMDG Packaging Group:** II
**ID No.:** UN1854

*MSDS Collection* **References:** 7, 26, 38, 73, 85, 87, 89, 100, 103, 109, 123, 124, 126, 127, 133, 136, 138, 139
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD

## Section 6. Health Hazard Data

**Carcinogenicity:** The ACGIH, OSHA, and IARC list benzene as, respectively, a supected human carcinogen, a cancer hazard, and, based on sufficient human and animal evidence, a human carcinogen (Group 1).
**Summary of Risks:** Prolonged skin contact or excessive inhalation of benzene vapor may cause headache, weakness, appetite loss, and fatigue. The most important health hazards are cancer (leukemia) and bone marrow damage with injury to blood-forming tissue from chronic low-level exposure. Higher level exposures may irritate the respiratory tract and cause central nervous system (CNS) depression.
**Medical Conditions Aggravated by Long-Term Exposure:** Exposure may worsen ailments of the heart, lungs, liver, kidneys, blood, and CNS.
**Target Organs:** Blood, central nervous system, bone marrow, eyes, upper respiratory tract, and skin.
**Primary Entry Routes:** Inhalation, skin contact.
**Acute Effects:** Symptoms of acute overexposure include irritation of the eyes, nose, and respiratory tract, breathlessness, euphoria, nausea, drowsiness, headache, dizziness, and intoxication. Severe exposure may lead to convulsions and unconsciousness. Skin contact may cause a drying rash (dermatitis).
**Chronic Effects:** Long-term chronic exposure may result in many blood disorders ranging from aplastic anemia (an inability to form blood cells) to leukemia.
**FIRST AID**
**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
**Skin:** *Quickly* remove contaminated clothing. Immediately rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
**Inhalation:** Remove exposed person to fresh air. Emergency personnel should protect against inhalation exposure. Provide CPR to support breathing or circulation as necessary. Keep awake and transport to a medical facility.
**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting* since aspiration may be fatal. Call a physician immediately.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Physician's Note:** Evaluate chronic exposure with a CBC, peripheral smear, and reticulocyte count for signs of myelotoxicity. Follow up any early indicators of leukemia with a bone marrow biopsy. Urinary phenol conjugates may be used for biological monitoring of recent exposure. Acute management is primarily supportive for CNS depression.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** *Design and practice a benzene spill control and countermeasure plan (SCCP).* Notify safety personnel, evacuate all unnecessary personnel, eliminate all heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation, eye contact, and skin absorption. Absorb as much benzene as possible with an inert, noncombustible material. For large spills, dike far ahead of spill and contain liquid. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of confined spaces such as sewers, watersheds, and waterways because of explosion danger. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
**EPA Designations**
Listed as a RCRA Hazardous Waste (40 CFR 261.33), Hazardous Waste No. U019
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1000 lb (454 kg) [* per Clean Water Act, Sec. 307 (a), 311 (b)(4), 112; and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as SARA Toxic Chemical (40 CFR 372.65)
**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000, Tables Z-1-A and Z-2)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations at least below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in tightly closed containers in a cool, dry, well-ventilated area away from all heat and ignition sources and incompatible materials. *Caution! Benzene vapor may form explosive mixtures in air.* To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas. When opening or closing benzene containers, use nonsparking tools. Keep fire extinguishers readily available.
**Engineering Controls:** Because OSHA specifically regulates benzene (29 CFR 1910.1028), educate workers about its potential hazards and dangers. Minimize all possible exposures to carcinogens. If possible, substitute less toxic solvents for benzene; use this material with extreme caution and only if absolutely essential. Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Designate regulated areas of benzene use (see legend in the box below) and label benzene containers with "DANGER, CONTAINS BENZENE, CANCER HAZARD."
**Other Precautions:** Provide preplacement and periodic medical examinations with emphasis on a history of blood disease or previous exposure.

**Transportation Data (49 CFR 172.101, .102)**

**DOT Shipping Name:** Benzene (*benzol*)
**DOT Hazard Class:** Flammable liquid
**ID No.:** UN1114
**DOT Label:** Flammable liquid
**DOT Packaging Exceptions:** 173.118
**DOT Packaging Requirements:** 173.119

**IMO Shipping Name:** Benzene
**IMO Hazard Class:** 3.2
**ID No.:** UN1114
**IMO Label:** Flammable liquid
**IMDG Packaging Group:** II

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE–NO SMOKING
AUTHORIZED PERSONNEL ONLY
RESPIRATOR REQUIRED

*MSDS Collection* **References:** 1, 2, 12, 26, 73, 84-94, 100, 101, 103, 109, 124, 126, 127, 132, 134, 136, 138, 139, 143
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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*Material Safety Data Sheets Collection:*

Sheet No. 316
**Benzene**

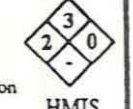
Issued: 11/78 Revision: E, 8/90

## Section 1. Material Identification 32

**Benzene ($C_6H_6$) Description:** Derived by fractional distillation of coal tar, hydrodealkylation of toluene or pyrolysis of gasoline, catalytic reforming of petroleum, and transalkylation of toluene by disproportionation reaction. Used as a fuel; a chemical reagent; a solvent for a large number of materials such as paints, plastics, rubber, inks, oils, and fats; in manufacturing phenol, ethylbenzene (for styrene monomer), nitrobenzene (for aniline), dodecylbenzene (for detergents), cyclohexane (for nylon), chlorobenzene, diphenyl, benzene hexachloride, maleic anhydride, benzene-sulfonic acid, artificial leather, linoleum, oil cloth, varnishes, and lacquers; for printing and lithography; in dry cleaning; in adhesives and coatings; for extraction and rectification; as a degreasing agent; in the tire industry; and in shoe factories. Benzene has been banned as an ingredient in products intended for household use and is no longer used in pesticides.

R 1
I 4
S 2*
K 4
*Skin absorption

NFPA




HMIS
H 3
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R 0
PPG†
† Sec. 8

**Other Designations:** CAS No. 0071-43-2, benzol, carbon oil, coal naphtha, cyclohexatriene, mineral naphtha, nitration benzene, phene, phenyl hydride, pyrobenzol.

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

**Cautions:** Benzene is a confirmed *human carcinogen* by the IARC. *Chronic low-level exposure may cause cancer (leukemia) and bone marrow damage, with injury to blood-forming tissue.* It is also a dangerous fire hazard when exposed to heat or flame.

## Section 2. Ingredients and Occupational Exposure Limits

Benzene, ca 100%*

**1989 OSHA PELs**
(29 CFR 1910.1000, Table Z-1-A)
8-hr TWA: 1 ppm, 3 mg/m³
15-min STEL: 5 ppm, 15 mg/m³

(29 CFR 1910.1000, Table Z-2)
8-hr TWA: 10 ppm
Acceptable Ceiling Concentration: 25 ppm
Acceptable Maximum Peak: 50 ppm (10 min)†

**1989-90 ACGIH**
TLV-TWA: 10 ppm, 32 mg/m³

**1988 NIOSH RELs**
TWA: 0.1 ppm, 0.3 mg/m³
Ceiling: 1 ppm, 3 mg/m³

**1985-86 Toxicity Data‡**
Man, oral, $LD_{Lo}$: 50 mg/kg; no toxic effect noted
Man, inhalation, $TC_{Lo}$: 150 ppm inhaled intermittently over 1 yr in a number of discrete, separate doses affects the blood (other changes) and nutritional and gross metabolism (body temperature increase)
Rabbit, eye: 2 mg administered over 24 hr produces severe irritation

* OSHA 29 CFR 1910.1000, Subpart Z, states that the final benzene standard in 29 CFR 1910.1028 applies to all occupational exposures to benzene except in some subsegments of industry where exposures are consistently under the action level (i.e., distribution and sale of fuels, sealed containers and pipelines, coke production, oil and gas drilling and production, natural gas processing, and the percentage exclusion for liquid mixtures); for the excepted subsegments, the benzene limits in Table Z-2 apply.
† Acceptable maximum peak above the acceptable ceiling concentration for an 8-hr shift.
‡ See NIOSH, *RTECS* (CY1400000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 176 °F (80 °C)
**Melting Point:** 42 °F (5.5 °C)
**Vapor Pressure:** 100 mm Hg at 79 °F (26.1 °C)
**Vapor Density (Air = 1):** 2.7
**Evaporation Rate (Ether = 1):** 2.8

**Molecular Weight:** 78.11
**Specific Gravity (15 °C/4 °C):** 0.8787
**Water Solubility:** Slightly (0.180 g/100 g of $H_2O$ at 25 °C)
**% Volatile by Volume:** 100
**Viscosity:** 0.6468 mPa at 20 °C

**Appearance and Odor:** A colorless liquid with a characteristic sweet, aromatic odor. The odor recognition threshold (100% of panel) is approximately 5 ppm (unfatigued) in air. Odor *is not* an adequate warning of hazard.

## Section 4. Fire and Explosion Data

| Flash Point: 12 °F (-11.1 °C), CC | Autoignition Temperature: 928 °F (498 °C) | LEL: 1.3% v/v | UEL: 7.1% v/v |
|---|---|---|---|

**Extinguishing Media:** Use dry chemical, foam, or carbon dioxide to extinguish benzene fires. Water may be ineffective as an extinguishing agent since it can scatter and spread the fire. Use water spray to cool fire-exposed containers, flush spills away from exposures, disperse benzene vapor, and protect personnel attempting to stop an unignited benzene leak.

**Unusual Fire or Explosion Hazards:** Benzene is a Class 1B flammable liquid. A concentration exceeding 3250 ppm is considered a potential fire explosion hazard. Benzene vapor is heavier than air and can collect in low lying areas or travel to an ignition source and flash back. Explosive and flammable benzene vapor-air mixtures can easily form at room temperature. Eliminate all ignition sources where benzene is used, handled, or stored.

**Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Structural firefighter's protective clothing provides limited protection. Stay out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Runoff to sewer can create pollution, fire, and explosion hazard.

## Section 5. Reactivity Data

**Stability/Polymerization:** Benzene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Benzene explodes on contact with diborane, permanganic acid, bromine pentafluoride, peroxodisulfuric acid, and peroxomonosulfuric acid. It ignites on contact with dioxygen difluoride, dioxygenyl tetrafluoroborate, iodine heptafluoride, and sodium peroxide + water. Benzene forms sensitive, explosive mixture with iodine pentafluoride, ozone, liquid oxygen, silver perchlorate, nitryl perchlorate, nitric acid, and arsenic pentafluoride + potassium methoxide (explodes above 30 °C). A vigorous or incandescent reaction occurs with bromine trifluoride, uranium hexafluoride, and hydrogen + Raney nickel [above 410 °F (210 °C)]. Benzene is incompatible with oxidizing materials.

**Conditions to Avoid:** Avoid heat and ignition sources.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of benzene can produce toxic gases and vapors such as carbon monoxide.

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*Material Safety Data Sheets Collection:*

Sheet No. 59
**Beryllium Metal/Powder**

Issued: 4/80 Revision: A, 11/89

## Section 1. Material Identification 30

**Beryllium Metal/Powder Description:** A naturally occurring ore found in chrysoberyl ($Be_2SiO_4$) or produced industrially from beryl ($3BeO.Al_2O_3.6SiO_2$). The ore is converted to the oxide or hydroxide, then to the fluoride or chloride. The halide may be reduced in a furnace by magnesium metal or by electrolysis. An alternative purification process is a liquid-liquid extraction with an organophosphate chelating agent. Used in aerospace structures, radio tube parts, inertial guidance systems, computer parts, Be-Cu alloys, gyroscopes; used as an additive in solid propellant rocket fuels, as a neutron source when bombarded with alpha particles, and as a neutron moderator and reflector in nuclear reactors.
**Other Designations:** Glucinium; Be; CAS No. 7440-41-7.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 2
K 1

Genium


HMIS
H 4
F 1
R 0
PPG*
* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Beryllium and compounds, ca 100%

**OSHA PELs**
8-hr TWA: 0.002 ppm
30-min STEL: 0.005 ppm
Ceiling level: 0.025 ppm

**ACGIH TLV, 1989-90***
TLV-TWA: 0.002 mg/m³
**NIOSH REL, 1987***
Not to exceed 0.5 µg/m³

**Toxicity Data†**
Human, inhalation, $TC_{Lo}$: 300 mg/m³, pulmonary effects
Rabbit, intravenous, $TD_{Lo}$: 20 mg/kg, neoplastic effects

* These values are for beryllium and its compounds.
† See NIOSH, *RTECS* (DS1750000), for additional data with references to mutagenic and tumorigenic effects.

## Section 3. Physical Data

**Boiling Point:** 5378 °F (2970 °C)
**Melting Point:** 2332 °F (1278 °C)
**Vapor Pressure:** 7.6 mm Hg at 3470 °F (1910 °C)
**Atomic Weight:** 9.01 g/mol

**Specific Gravity ($H_2O$ = 1 at 39 °F (4 °C)):** 1.848 at 68 °F (20 °C)
**Water Solubility, hot water:** Slight
**cold water:** Insoluble

**Appearance and Odor:** A grayish-white metal with a hexagonal and aniostropic crystal structure (i.e., their index of refraction varies with incident light direction), and a powdered metal, no odor.

## Section 4. Fire and Explosion Data

| **Flash Point:** None reported | **Autoignition Temperature:** Powder, ca 1200 °F (649 °C) | **LEL:** None reported | **UEL:** None reported |
|---|---|---|---|

**Extinguishing Media:** *Never* use water or $CO_2$. Instead, smother the fire with an approved dry-powder extinguisher. Sand, graphite powder, and sodium chloride are also recommended.
**Unusual Fire or Explosion Hazards:** Beryllium can be a moderate fire hazard if exposed to flame. The hazards increase as particulate size decreases. A beryllium dust cloud can be explosive (areas where dusting may occur require Class 2, Group E electrical services, 29 CFR 1910.309). This material's combustion products are *highly toxic*.
**Special Fire-fighting Procedures:** Fire fighters should use full protective clothing, eye protection, and a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. After exposure to a beryllium fire, they should clean equipment and bathe carefully.

## Section 5. Reactivity Data

**Stability/Polymerization:** Beryllium is stable at room temperature in closed containers.* Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** Acid and alkali soluble, it reacts with strong bases to evolve hydrogen.† Warm beryllium reacts incandescently with phosphorus, fluorine, or chlorine. Molten lithium metal at 356 °F (180 °C) severely attacks beryllium metal.
**Conditions to Avoid:** When heated in air or in mixed $CO_2$ and nitrogen, beryllium is ignitable. Mixtures of the powdered metal with $CCl_4$ or trichloroethylene flash on heavy impact.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of beryllium emits very toxic oxide of beryllium fumes.

* When moist, beryllium forms thin, acid-resistant oxide films on solid surfaces.
† A simple asphyxiant gas, hydrogen is extremely flammable.

## Section 6. Health Hazard Data

**Carcinogenicity:** The NTP, IARC, and ACGIH list beryllium as a carcinogen. Animal studies also indicate that beryllium produces lung and bone tumors.
**Summary of Risks:** Beryllium is highly toxic by inhalation of fume or dust and exposure to this element and its salts may cause death. Inhaled beryllium is partially deposited in the lungs, the blood system, and finally the bones, thus affecting all organ systems. Since the human body does not quickly eliminate beryllium, trace amounts in urine are detectable as long as 10 years after exposure. Prolonged or repeated skin contact can cause skin irritation or dermatitis. Eye contact can produce conjuctivitis and eye ulcers. If introduced through the skin via cuts or punctures, nonhealing ulcers may develop.

*Continue on next page*

## Section 6. Health Hazard Data, continued

**Medical Conditions Aggravated by Long-Term Exposure:** Increased risk of lung, liver, gall bladder, and bile duct cancers. **Target Organs:** Lungs, mucous membranes, eyes, skin. **Primary Entry:** Inhalation. **Acute Effects:** Symptoms may occur up to 72 hr after a massive exposure. Acute inhalation can produce pneumonitis with inflammation of the upper and lower respiratory tracts, nasal congestion, nonproductive coughing, and pulmonary edema. High dose exposures may cause acute respiratory distress, brain hemorrhaging, liver inflammation, and spleen hemorrhaging. **Chronic Effects:** Symptoms may be delayed up to 15 years. Chronic exposures result from long-term exposure to small (microgram) quantities and can produce berylliosis. Berylliosis is a progressive granuloma formation in the lungs which eventually causes increasing shortness of breath and, in some cases, death. Since it also circulates among other organs, beryllium causes eventual heart enlargement and failure, liver and spleen enlargement, kidney stones, various malignant tumors, and damaging cell death in any organ in which it accumulates.

**FIRST AID**

**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

**Skin:** After rinsing affected area with flooding amounts of water, wash it with soap and water. **Inhalation:** Remove exposed person to fresh air and support breathing as needed. **Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear. Present studies indicate that beryllium is so poorly absorbed through the intestinal tract, that ingestion is not an important hazard (*Industrial Toxicology*, 3rd Edition, Hamilton).

**After first aid, get appropriate in-plant, paramedic, or community medical attention and support.** Watch for signs of respiratory deterioration, and use oxygen as needed.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** If powdered metal is spilled, notify safety personnel. Evacuate area except for cleanup personnel with protective equipment against contact or inhalation hazards. Provide ventilation and remove heat and ignition sources. To prevent dusting conditions, vacuum or wet mop powder spills. Collect particulate scrap, absorb on paper, and transfer to a sealed recovery or disposal container. **Disposal:** Dissolve beryllium in a small amount of 6M-HCl, filter it, and add a slight excess of 6M-$NH_4OH$ to the filtrate using litmus as an indicator (blue at pH 8.3). Heat and coagulate the precipitate. After 12 hr, filter and dry it. Handle beryllium waste unsuitable for recycling in accordance with Federal, state, and local regulations. Dispose of scrap or waste material by arranging its return to the supplier in a mutually acceptable form. Contact your supplier or a licensed contractor for detailed recommendations.

**OSHA Designations**

Listed as Air Contaminant (29 CFR 1910.1000, Table Z-2)

**EPA Designations**

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001; per Clean Water Act, Sec. 307(a), 112]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator for emergency and nonroutine use in concentrations above the 8-hr, 2-μg/m³ TWA. For any time period, a half-mask, air-purifying respirator with a high-efficiency filter is suitable for concentrations as high as 25-μg Be/m³ (see NIOSH, *A Recommended Standard for Occupational Exposure to Beryllium*, Sec. 4). A powered, air-purifying respirator equipped with a "fume filter" is suitable for concentrations up to 40 μg Be/m³. A full facepiece, air-purifying respirator with a high-efficiency filter is suitable for concentrations up to 100 μg Be/m³. A powered, air-purifying respirator equipped with a high-efficiency filter, operating in the positive-pressure mode, is suitable for concentrations up to 1000 μg Be/m³. An SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode is suitable for concentrations above 1000 μg Be/m³. Follow OSHA respirator regulations (29 CFR 1910.134). **Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. When exposure levels exceed the TLV, change into clean protective clothing and shower at the end of your shift. **Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL standards (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103). **Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities. **Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment. **Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Clearly label and store beryllium away from incompatible materials (Sec. 5) in a clean, dry, low fire-hazard area. Protect containers from physical damage. **Engineering Controls:** Provide adequate ventilation in areas where beryllium can become airborne. Monitor these areas with personal samplers to limit and control exposure levels. Teach workers about beryllium's potential hazards. Practice good housekeeping to prevent accumulation of beryllium-containing deposits. Give preplacement and annual medical exams (chest x-rays, baseline pulmonary function tests [$FVC_1$ (functional vital capacity) and $FEV_1$ (the amount of air exhaled in the first second after maximum inhalation)] and body weight measurements to workers possibly exposed to concentrations above the TLV. Prevent exposing those with pulmonary disease, chronic skin, liver, heart, or kidney conditions; abnormal chest x-ray or blood count; or vital capacity depression greater than 10%. Ensure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, producing, and sampling operations.

**Transportation Data (49 CFR 172.101, .102)**

**DOT Shipping Name:** Beryllium compound, n.o.s.

**DOT Hazard Class:** Poison B

**DOT ID No.:** UN1567

**IMO Shipping Name:** Beryllium, metal powder

**IMO Hazard Class:** 6.1

**IMO Label:** Poison, flammable solid

*MSDS Collection* References: 1-12, 18-20, 24-26, 81, 84, 85, 88-91, 100, 116, 117

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** Warren Silverman, MD

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# Material Safety Data Sheet

from Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 23

CADMIUM
(Revision C)
Issued: September 1977
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION

Material Name: CADMIUM

Description (Origin/Uses): Used in electroplating other metals; in dentistry; in alloys; in nickel-cadmium batteries; and in reactor control rods.

Other Designations: Cd; CAS No. 7440-43-9

Manufacturer: Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

Genium

HMIS
H 3 R 1
F 1 I 4
R 0 S 1
PPG* K 4 (Dust)
*See sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS, EXPOSURE LIMITS

Cadmium, CAS No. 7440-43-9, ca 100%

**OSHA PEL**
8-Hr TWA: 0.1 mg/m³ (Cd Fume)
Ceiling: 0.3 mg/m³ (Cd Fume)
8-Hr TWA: 0.2 mg/m³ (Cd Dust)
Ceiling: 0.6 mg/m³ (Cd Dust)

**ACGIH NIC,* 1988-89**
TLV-TWA: 0.01 mg/m³ (Cadmium and Compounds, as Cd)
ACGIH A2, Suspected Human Carcinogen

**ACGIH TLVs, 1988-89**
TLV-TWA: 0.05 mg/m³ (Cadmium Dusts and Salts, as Cd)
TLV-Ceiling: 0.05 mg/m³ (Cadmium Oxide Fume, as Cd)
TLV-TWA: 0.05 mg/m³ (Cadmium Oxide Production)

**Toxicity Data****
Human, Inhalation, $LC_{Lo}$: 39 mg/m³ (20 Minutes)

*Notice of Intended Changes, Genium reference 116, p. 39.
**See NIOSH, *RTECS* (EU9800000), for additional data referring to reproductive, tumorigenic, and mutagenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 1413°F (767°C)
**Melting Point:** 610°F (321°C)
**Vapor Pressure:** 0.095 Torr at 610°F (321°C)
**Molecular Weight:** 112 Grams/Mole
**Solubility in Water (%):** Insoluble
**Specific Gravity ($H_2O$ = 1):** 8.642

**Appearance and Odor:** A soft, blue white, malleable, lustrous metal that can be cut easily with a knife; odorless.
**Comments:** Cadmium has a significant vapor pressure of 0.000021 torr (corresponding to 0.12 mg/m³) at 315°F (157°C). Heating this metal without using correct engineering controls and/or personal protective equipment can result in overexposure.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method* | Autoignition Temperature* | LEL* | UEL* |
|---|---|---|---|

**Extinguishing Media:** *Cadmium metal burns readily in air if it is heated. As with most metals, the reactivity/dust-cloud-explosion hazard increases as the cadmium metal becomes more finely divided. In fact, finely divided, powdered cadmium metal can be pyrophoric (it burns spontaneously in air without any source of ignition). Carbon dioxide, dry chemical, or sand are recommended extinguishing agents for cadmium fires. **Unusual Fire or Explosion Hazards:** Cadmium dust can explode during a fire. Massive cadmium metal does not present this potential explosion hazard; however, certain work operations such as grinding, welding, or cutting, can produce dust made of finely divided cadmium particles. **Warning:** Do not create a dust cloud of cadmium particles, especially during cutting, grinding, or welding operations. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

**Stability/Polymerization:** Cadmium is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Cadmium reacts dangerously with ammonium nitrate, hydrazoic acid, tellurium, and zinc (Genium ref. 84). **Conditions to Avoid:** Avoid all exposure to sources of ignition and to incompatible chemicals. **Hazardous Products of Decomposition:** When heated, which is likely during fires and work operations such as welding and machining, cadmium metal can decompose into cadmium metal fume and cadmium oxide fume.

## SECTION 6. HEALTH HAZARD INFORMATION

**Carcinogenicity:** The ACGIH classifies cadmium and its compounds as suspected human carcinogens (group A2); the IARC lists them as probable human carcinogens (group 2B); and the NTP classifies them as anticipated human carcinogens (group b). **Summary of Risks:** Heating cadmium metal produces intensely irritating cadmium metal fume. The acute effects of its excessive inhalation, which include severe tracheobronchitis, pneumonitis, and pulmonary edema, are life threatening and are usually delayed for several hours; their mortality rate is about 20%. Nonfatal pneumonitis has resulted from exposure to 0.5 to 2.5 mg/m³; a fatality has been reported for five hours' exposure at 9 mg/m³ and for 1 hour's exposure at 40 to 50 mg/m³. There is no warning discomfort or immediate irritation from exposure to cadmium fume. Acute gastroenteritis and symptoms of metal fume fever are associated with even lower acute exposure. Symptoms of acute overexposure include excessive salivation, a dry, burning throat; headache; aching muscles; coughing; chest tightness and pain; nausea; chills, and fever chills; and fever. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, kidneys, and blood. **Primary Entry:** Inhalation, skin contact. **Acute Effects:** See Summary of Risks, above. **Chronic Effects:** Long-term, chronic inhalation of cadmium dust, salts, or fume causes chronic cadmium poisoning characterized by a distinctive, nonhypertrophic emphysema with or without renal tubular injury, accompanied by the urinary excretion of a protein with a molecular weight

## SECTION 6. HEALTH HAZARD INFORMATION, cont.

of 20,000 to 30,000. This protein is itself a sign of early but reversible chronic poisoning. (Possible chromosomal aberrations and decreased birth weight among babies of women exposed to cadmium have been noted.) **Danger:** Continued overexposure from inhalation causes irreversible renal tubular damage. Cancer, anemia, eosinophilia, anosmia, chronic rhinitis, yellowed teeth, and bone changes have been reported. Bone pain in the ribs, backbone, and femur is common; disorders of calcium metabolism develop; and kidney stones and pulmonary fibrosis have been described. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** If a physician is not readily available, give the exposed person 2 to 3 glasses of water to drink and induce vomiting. A physician may administer a gastric lavage followed by saline catharsis. **Comments:** A comprehensive medical program is advised for those who work with cadmium or its compounds. This should include chest X rays and forced-vital-capacity tests. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Chelation therapy may be useful in treatment; calcium disodium edetate and pencillamine are recommended. Dimercaprol (BAL) is not recommended because of reported renal toxicity of the cadmium-BAL complex.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate ventilation. Cleanup procedures must not create dusty conditions. Pick up the spilled material using vacuuming, mopping, or wet-sweeping techniques. Cleanup personnel need protection against inhalation of dust and fume (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations. Concentrated solutions of cadmium waste can be precipitated with lime and collected by filtration. Effluent should be treated as needed to reduce the concentration of the cadmium to a level that is within regulatory compliance limits.

**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
**EPA Designations (40 CFR 302.4)**
RCRA Hazardous Waste, No. D006 (40 CFR 261.24 [Characteristic of EP toxicity])
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per the Clean Water Act (CWA), § 307 (a).

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing of a cadmium solution is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems powerful enough to maintain airborne levels of cadmium below the OSHA PEL cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommnedations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. Do not wear work clothes home. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale cadmium fume. Do not expose individuals with lung, liver, kidney, and blood ailments to cadmium until such exposure is approved by a physician.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store cadmium in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. Avoid storage situations where corrosion can occur. Keep powdered cadmium in closed containers; prevent the airborne dispersion of powdered cadmium. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, producing, and sampling operations to prevent static sparks. **Other Precautions:** The toxic effects of cadmium are influenced by the presence or absence of other elements such as zinc and selenium. If these materials are present in the workplace, careful evaluation of any exposure to cadmium is required to understand any contributing factors.

**Hazardous Materials Table (49 CFR 172.101):** Not Listed
**Optional Hazardous Materials Table (49 CFR 172.102)**

ID No. UN2570

**IMO Shipping Name:** Cadmium Compounds
**IMO Hazard Class:** 6.1
**IMO Labels:** Poison or Saint Andrew's Cross (X)*

*Harmful—Stow away from Foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

**References:** 1, 26, 38, 84-94, 100, 116, 117, 120, 122.



Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: W Silverman, MD

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*Material Safety Data Sheets Collection:*

**Sheet No. 83**
**Chromium Metal/Powder**

Issued: 3/81 Revision: A, 11/89

## Section 1. Material Identification 30

**Chromium Metal/Powder Description:** Obtained from chrome ore, chromite ($FeCr_2O_4$), by electrolysis of chromium solutions, by direct reduction (ferrochrome), and by reducing the oxide with finely divided carbon or aluminum. Used for chromeplating other metals; for greatly increasing metal resistance and durability; in manufacturing chrome-steel or chrome-nickel-steel alloys (stainless steel); as a constituent of inorganic pigments; as protective coating for automotive and equipment accessories; and in nuclear and high-temperature research.
**Other Designations:** Chrome; Cr; CAS No. 7440-47-3.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide* (Genium ref. 73) for a suppliers list.

R 1
I 4
S 1
K 1

Genium


HMIS
H 2
F 1
R 1
PPG*
* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Chromium metal/powder, ca 100%

| OSHA PEL | ACGIH TLV, 1988-89* | NIOSH REL, 1987† | Toxicity Data‡ |
|---|---|---|---|
| 8-hr TWA: 1 mg/m³ | TLV-TWA: 0.5 mg/m³ | 8-hr TWA (for chromium metal and insoluble salts): 1 mg Cr/m³ | Rat, implant, $TD_{Lo}$: 1200 µg/kg body weight administered intermittently over six weeks |

* This TLV is applicable to $Cr^{+2}$ and $Cr^{+3}$ compounds. For water soluble and water-insoluble $Cr^{+6}$, the 8-hr TWA is 0.05 mg Cr $^{+6}$/m³. Certain water-insoluble $Cr^{+6}$ compounds (zinc chromate, calcium chromate, lead chromate, barium chromate, strontium chromate, and sintered chromium trioxide) are designated as A1a (human carcinogen).
† The NIOSH REL (10-hr TWA) for carcinogen $Cr^{+6}$ compounds is 1 µg/m³; for noncarcinogenic $Cr^{+6}$ compounds (including chromic acid), the RELs (10-hr TWAs) are 25 µg/m³ and 50 µg/m³ (15-min ceiling ). The noncarcinogenic compounds include mono- and dichromates of hydrogen, cesium, sodium, lithium, potassium, rubidium, ammonia, and $Cr^{+6}$ (chromic acid anhydride). Any and all $Cr^{+6}$ materials excluded from the noncarcinogenic group above are carcinogenic $Cr^{+6}$ compounds.
‡ See NIOSH, *RTECS* (GB4200000), for additional data with references to tumorigenic effects.

## Section 3. Physical Data

**Boiling Point:** 4788 °F (2642 °C)
**Melting Point:** 3452 °F (1900 °C)
**Vapor Pressure:** 1 mm Hg at 2941 °F (1616 °C)
**Vapor Density (Air = 1):** 1.79
**Atomic Weight:** 51.996 g/mol
**Specific Gravity ($H_2O$ = 1 at 39 °F (4 °C)):** 7.2 at 68 °F (20 °C)
**Water Solubility:** Insoluble

**Appearance and Odor:** Steel-gray, lustrous metal; no odor.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: Cloud, 1076 °F (580 °C); dust layer, 752 °F (400 °C) | LEL: Dust cloud explosion, 0.230 oz/ft³ | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Use dry chemical or sand.
**Unusual Fire or Explosion Hazards:** Particle size and dispersion in air determine reactivity. Chromium powder explodes spontaneously in air, while chromium dust suspended in $CO_2$ is ignitable and explosive when heated.
**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

*One hundred percent of dust goes through a 74-µm sieve. A 140-mJ spark can ignite a dust cloud.

## Section 5. Reactivity Data

**Stability/Polymerization:** Chromium is stable when properly handled and stored. Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** Chromium reacts readily with dilute, not nitric, acids to form chromous salts. It is soluble in acids (not nitric) and strong alkalis. Its powder is incompatible with strong oxidizing agents, including high $O_2$ concentration. Evaporation of mercury (Hg) from Cr amalgam leaves pyrophoric chromium. Finely divided Cr attains incandescence with nitrogen oxide, potassium chlorate, and sulfur dioxide. Molten lithium at 18 °C severely attacks Cr. Fused ammonium nitrate below 200 °C reacts explosively and may ignite or react violently with bromine pentafluoride.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of Cr can produce toxic chromium oxide fumes.

## Section 6. Health Hazard Data

**Carcinogenicity:** The NTP and OSHA list chromium as a human carcinogen.

**Summary of Risks:** When ingested chromium is a human poison, with gastrointestinal (GI) effects. Chromium 3 ($Cr^{+3}$) compounds show little or no toxicity. Less soluble chromium 6 ($Cr^{+6}$) compounds are suspected carcinogens and severe irritants of the larynx, nasopharynx, lungs, and skin (Sec. 2). Chromic acid or chromate salts cause irritation of the skin and respiratory passage. Ingestion leads to severe irritation of the gastrointestinal tract, renal damage, and circulatory shock. Chromium metal (when heated to high temperatures) and insoluble salts are said to be involved in histological fibrosis of the lungs, which may progress to clinically evident pneumoconiosis. Exposure to chromate dust and powder can cause skin (dermatitis) and eye irritation (conjunctivitis).

**Medical Conditions Aggravated by Long-Term Exposure:** An incresed incidence of bronchogenic carcinoma occurs in workers exposed to chromate dust.

**Target Organs:** Respiratory system.

**Primary Entry:** Inhalation, percutaneous absorption, and ingestion.

**Acute Effects:** Acute exposures to dust may cause headache, coughing, shortness of breath, pneumoconiosis, fever, weight loss, nasal irritation, inflammation of the conjunctiva, and dermatitis.

**Chronic Effects:** Asthmatic bronchitis.

FIRST AID

**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

**Skin:** Brush off chromium dust. After rinsing affected area with flooding amounts of water, wash it with soap and water.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that conscious person slowly drink 1 to 2 glasses of water to dilute. Do not induce vomoting. A physician should evaluate all ingestion cases.

**After first aid, get appropriate in-plant, paramedic, or community medical attention and support.**

**Physician's Note:** Acute toxicity causes a two-phase insult: 1) multisystem shock due to gastrointestinal corrosivity and 2) hepatic, renal, hematopoetic insult. Treatment should use ascorbic acid as a neutralizer with gastric lavage. If the ingestion is substantial, exchange transfusions and/or consider hemodialysis. Treat allergic dermatitis with local cortisone or 10% ascorbic acid to reduce $Cr^{+6}$ to $Cr^{+3}$. Ten percent EDTA in a lanolin base applied every 24 hr helps heal skin ulcers.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel of large spills. Cleanup personnel should wear protective clothing and approved respirators. Remove heat and ignition sources. Provide adequate ventilation. Keep airborne dust at a minimum. Remove spills quickly and place in appropriate containers for disposal or reuse.

**Disposal:** Reclaim salvageable metal. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1 )

**EPA Designations**

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Wear a NIOSH-approved respirator if necessary. Wear an SCBA with a full facepiece when the particle concentration's upper limit is 50 $mg/m^3$.

**Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

**Other:** Wear impervious rubber gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA standard (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by eliminating it at its source (Genium ref. 103).

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Launder contaminated clothing before wearing. Remove this material from your shoes and equipment.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store material in cool, dry, well-ventilated area separate from acids and oxidizing agents. Seal and protect containers from physical damage. Keep away from heat or ignition sources.

**Engineering Controls:** Avoid dust inhalation. Practice good housekeeping (vacuuming and wet sweeping) to minimize airborne particulates and to prevent dust accumulation. Use nonsparking tools and ground electrical equipment and machinery.

**Transportation Data (49 CFR 172.101, .102):** Not listed

*MSDS Collection* **References:** 1, 2, 26, 38, 80, 87, 88, 89, 100, 109, 124, 126

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD M3

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*Material Safety Data Sheets Collection:*

Sheet No. 162
Copper

Issued: 12/85 Revision: A, 8/90

## Section 1. Material Identification

32

**Copper (Cu) Description:** Widely distributed in nature in elemental state, arsenites, sulfides, chlorides, and carbonates. Prepared by crushing, grinding, and concentrating copper ores by flotation and leaching or by smelting copper ore concentrates to yield a blister (96 to 98%) copper which is electrolytically refined to yield 99.9+% copper. Copper is the most widely used structural metal, next to iron and aluminum. Used in electric wiring; switches, heating, plumbing, roofing, and building construction; alloys (brass, bronze, Monel metal, beryllium-copper); coins; chemical and pharmaceutical machinery; electroplated protective coatings and undercoats for nickel, chromium, zinc, etc., cooking utensils; insecticides; antifouling paints; and as a catalyst. Copper whiskers are used in thermal and electrical composites. Copper flakes are used as insulation for liquid fuels.

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* Sec. 8

**Other Designations:** CAS No. 7440-50-8, bronze powder, copper slag-airborne, copper slag-milled.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.
**Cautions:** *Copper may be toxic through contact, inhalation, and ingestion.* It may cause skin and eye irritation and metal fume fever. Copper is not considered a fire hazard, but fine particles may burn in air.

## Section 2. Ingredients and Occupational Exposure Limits

Copper, ca 100%

| 1989 OSHA PELs | 1989-90 ACGIH TLVs | 1988 NIOSH REL | 1985-86 Toxicity Data‡ |
|---|---|---|---|
| 8-hr TWA: 1 mg/m³* | TLV-TWA: 1 mg/m³* | None established | Human, oral, $TD_{Lo}$: 120 µg/kg affects the gastrointestinal tract (nausea or vomiting) |
| 8-hr TWA: 0.1 mg/m³† | TLV-TWA: 0.2 mg/m³† | | Rat, oral, $TD_{Lo}$: 1210 µg/kg (35 weeks prior to mating) affects fertility (pre- and post-implantation mortality) |

* Copper dusts and mists, as Cu.
† Copper fume.
‡ See NIOSH, *RTECS* (GL5325000), for additional reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 4703 °F (2595 °C)
**Melting Point:** 1981 °F (1083 °C)
**Vapor Pressure:** 1 mm Hg at 2962 °F (1628 °C)
**Molecular Weight:** 63.546
**Density/Specific Gravity:** 8.94
**Water Solubility:** Insoluble

**Appearance and Odor:** Solid, various shapes, odorless, red/brown-colored metal or powder. Copper is ductile, tough, and easily worked. It is very resistant to corrosion, but readily attacked by alkalies.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Use extinguishing media appropriate to the surrounding fire since copper does not burn. Finely divided copper burns in air, and in extreme cases ignites spontaneously.
**Unusual Fire or Explosion Hazards:** Liquid copper explodes on contact with water. High concentrations of fine copper particles in the air may present an explosion hazard.
**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit.

## Section 5. Reactivity Data

**Stability/Polymerization:** Copper is stable at room temperature in closed containers under normal storage and handling conditions. However, on long standing, a white, highly explosive peroxide deposit may form. Copper's vapors are uninhibited and may form polymers in vents and flame arresters.
**Chemical Incompatibilities:** Copper reacts violently with ammonium nitrate, bromates, iodates, chlorates, ethylene oxide, hydrazoic acid, potassium oxide, dimethyl sulfoxide + trichloroacetic acid, hydrogen peroxide, sodium peroxide, sodium azide, sulfuric acid, hydrogen sulfide + air, and lead azide. A potentially explosive reaction occurs with actylenic compounds. Copper ignites on contact with chlorine, fluorine [above 250 °F (121 °C)], chlorine trifluoride, and hydrazinium nitrate [above 158 °F (70 °C)]. It is also incompatible with 1-bromo-2-propyne; an incandescent reaction occurs with potassium dioxide.
**Conditions to Avoid:** Avoid prolonged exposure to air and moisture. On exposure to moist air, copper slowly converts to the carbonate.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of copper can produce metallic oxides (copper fumes).

## Section 6. Health Hazard Data

**Carcinogenicity:** The NTP, IARC, and OSHA do not list copper as a carcinogen. Experimental studies show tumorigenic and teratogenic effects in laboratory animals.

**Summary of Risks:** Copper is a necessary human nutrient, excessive intake levels of which the kidneys normally eliminate. In individuals with kidney disease or, rarely, Wilson's disease (abnormal retention and storage of copper in the body that damages the liver, kidneys, brain, blood, bones, and endocrine glands), copper levels may accumulate. Significant industrial exposure to copper occurs mainly through inhalation of fumes during welding, smelting, or refining operations; or through exposure to copper dusts and mists during mining, extracting, refining, or manufacturing processes. Copper particles may irritate, discolor, and damage eyes. Exposure to copper salts in many applications is potentially toxic. Copper dusts, fumes, and salts may irritate the upper respiratory tract. Long-term exposure may irritate the skin and discolor the skin or hair.

**Medical Conditions Aggravated by Long-Term Exposure:** Individuals with impaired pulmonary or renal function should avoid exposure.

**Target Organs:** Respiratory system, skin, eyes, liver, kidneys.

**Primary Entry Routes:** Inhalation, ingestion.

**Acute Effects:** Inhalation of copper fumes may give rise to metal fume fever (after an incubation period of about 5 hr), an allergic reaction with flu-like symptoms—high temperature, metallic taste, nausea, coughing, general weakness, muscle aches, and exhaustion. These symptoms usually disappear within 24 hr. Direct contact with copper causes skin and (less often) eye irritation, and itching of the linings of the nose, mouth, and respiratory tract. Exposure to copper dust may cause a greenish-black skin discoloration. Copper ingestion causes nausea, vomiting, abdominal pain, and diarrhea. Ingestion of large doses may cause stomach and intestine ulceration, jaundice, and kidney and liver damage.

**Chronic Effects:** Continued exposure to copper may cause mild dermatitis and degeneration of the mucous membranes. Repeated or prolonged exposure to copper dusts and mists can discolor skin and hair and irritate the skin. Repeated inhalation can cause chronic respiratory disease. Individuals with Wilson's disease (1 in 200,000 individuals) are more susceptible to chronic copper poisoning. If undetected and untreated, this progressive condition is eventually fatal.

**FIRST AID**

**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

**Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

**Inhalation:** Remove exposed person to fresh air and support breathing with artificial respiration.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting.

**After first aid, get appropriate in-plant, paramedic, or community medical support.**

**Physician's Note:** A blood count shows leucocytosis if an individual has metal fume fever. Consider chellation with penicillamine or BAL (British Anti-Lewisite or dimercaprol) for chronic intoxication.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel, remove all heat and ignition sources, and provide adequate ventilation. Avoid creating dusty conditions. Cleanup personnel should protect against vapor inhalation and skin and eye contact. Cleanup methods such as vacuuming (with the appropriate filter) or wet mopping minimizes dust dispersion. Absorb liquid containing copper with vermiculite, dry sand, or other inert materials. Place in appropriate containers for disposal. Follow applicable OSHA regulations (29 CFR 1910.120).

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations**

RCRA Hazardous Waste (40 CFR 261.33): Not listed

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 5000 lb (2270 kg) [* per Clean Water Act, 307(a)]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Some recommendations follow. For copper dust and mists greater than 50 mg/m$^3$, wear a high-efficiency particulate respirator, a supplied-air respirator, or an SCBA, all with a full facepiece. For copper dust and mists greater than 2000 mg/m$^3$, wear a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. For copper fumes over 100 mg/m$^3$, wear either a powered air-purifying respirator with a high-efficiency filter, or a supplied-air respirator equipped either with a full facepiece operated in pressure-demand or positive-pressure mode or with a hood in continuous-flow mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. Eye and face protection is required when grinding, welding, cutting, or remelting. Protect skin from molten metal and radiant heat when melting scrap. Machine turnings may also present a laceration hazard. When handling oil-contaminated copper, wear rubber gloves to prevent skin contact.

**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below OSHA PELs and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store copper in tightly closed containers in a cool, dry, well-ventilated area. Avoid exposure to air and moisture.

**Engineering Controls:** Avoid dust and fume inhalation and direct contact with skin and eyes. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures. Maintain exposures below the PEL/TLV. Monitor copper dust and mist levels in the air.

**Other Precautions:** Provide placement and periodic examinations that emphasize the skin, eyes, and respiratory system. Prevent exposing individuals with chronic respiratory disease or Wilson's disease.

**Transportation Data (49 CFR 172.101, .102):** Not listed

*MSDS Collection* **References:** 26, 38, 73, 84, 88, 89, 100, 101, 103, 109, 124, 126, 127, 132, 133, 134, 136, 138, 139, 143, 144

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** W Silverman, MD; **Edited by:** JR Stuart, MS

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*Material Safety Data Sheets Collection:*

Sheet No. 789
**Cyanide**

Issued: 11/91

## Section 1. Material Identification



Cyanide ($CN^-$) Description: Derived by combining a carbon ion with a nitride ion. Used in rat and pest poisons, silver and metal polishes, photographic solutions, fumigating products, and electroplating solutions. Cyanide may also be liberated in burning of plastics, natural fabrics (wool or silk), polyurethane bedding or furniture, acrylic baths, nylon carpets, and melamine resin insulation.

Other Designations: CAS No. 57-12-5, carbon nitride ion, cyanide anion, isocyanide.

Manufacturer: Contact your supplier or distributor. Consult latest *Chemical Week Buyers' Guide*(73) for a suppliers list.

| | |
|---|---|
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| S | 2 |
| K | 1 |

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Cautions: Cyanide is severely toxic by all routes of entry and its lethal dose is an estimated 1 µg/ml. Take necessary precautions to avoid all possible exposure to this material.

## Section 2. Ingredients and Occupational Exposure Limits

Cyanide, ca 100%

**1990 OSHA PEL (Skin)**
STEL: 4.7 ppm, 5 mg/m³, as hydrogen cyanide (gas)

**1991-92 ACGIH TLV (Skin)**
Ceiling: 10 ppm, 11 mg/m³, as hydrogen cyanide (gas)

**1990 DFG (Germany) MAK** (*Danger of cutaneous absorption*)
TWA: 10 ppm, 11mg/m³ as hydrogen cyanide (gas)

**1985-86 Toxicity Data***
Mouse, intraperitoneal, $LD_{50}$: 3 mg/kg; toxic effects not yet reviewed

**1990 IDLH Level**
50 mg/m³

**1990 NIOSH REL (Skin)**
STEL: 4.7 ppm, 5 mg/m³ as hydrogen cyanide (gas)

* See NIOSH, *RTECS* (GS7175000), for additional toxicity data.

## Section 3. Physical Data

**Boiling Point:** Varies with specific $CN^-$ compound
**Melting Point:** Varies with specific $CN^-$ compound
**Molecular Weight:** 26.02
**Density:** Varies with specific $CN^-$ compound
**Water Solubility:** Varies with specific $CN^-$ compound

Appearance and Odor: Varies with specific $CN^-$ compound, but usually has an almond odor.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Cyanide is combustible. For small fires, use dry chemical, water spray or foam. *Do not use carbon dioxide ($CO_2$)!* For large fires, use water spray, fog, or regular foam. *Do not scatter* material with more water than needed to extinguish fire.

**Unusual Fire or Explosion Hazards:** Combustible by chemical reaction with heat, moisture, or acid. Many cyanides readily evolve hydrogen cyanide (HCN), a toxic flammable gas.

**Special Fire-fighting Procedures:** Since fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Structural firefighter's protective clothing *is ineffective* for fires involving cyanide. Wear chemical protective clothing that the shipper or manufacturer specifically recommends. If possible without risk, remove container from fire area. Fight fire from maximum distance. Stay away from ends of tanks. Be aware of runoff from fire control methods. Do not release to sewers or waterways. Remove and isolate contaminated clothing at the site.

## Section 5. Reactivity Data

**Stability/Polymerization:** Cyanide is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Cyanide may react violently with hypochlorite solutions at pH 10 to 10.3, is explosive with nitrites if heated above 450 °C, and is incompatible with chlorates, fluorine, magnesium, nitrates, and all inorganic acids.

**Conditions to Avoid:** Avoid exposure to heat and contact with incompatibles.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of cyanide can produce carbon dioxide and toxic, flammable vapors of $CN^-$.

## Section 6. Health Hazard Data

**Carcinogenicity:** In 1990 reports, the IARC, NTP, and OSHA do not list cyanide as a carcinogen.

**Summary of Risks:** Cyanide is a potent, fast-acting, chemical asphyxiant (material which causes pulse and breathing obstruction) that prevents tissue utilization of oxygen by inhibiting the enzyme involved (cytochrome oxidase). Death can occur within seconds to minutes after inhalation of some cyanide gases, and may take as long as an hour after ingestion of a large amount of a cyanide salt due to a slower absorption. Toxicity is dependent on the form of cyanide the victim is exposed to. Mortality from acute exposures is high, but recovery is generally complete in nonfatal cases.

**Medical Conditions Aggravated by Long-Term Exposure:** None reported.

*Continue next page*

## Section 6. Health Hazard Data, *continued*

**Target Organs:** Brain, heart, lungs, skin, blood.
**Primary Entry Routes:** Inhalation, ingestion, skin absorption.
**Acute Effects:** Inhalation of cyanide gases may cause rapid toxicity where the victim may only have time to utter a warning cry before succumbing to unconsciousness caused by asphyxiation. If exposure is small there may be a weak, rapid, irregular heartbeat with bright-pink coloration of the skin due to high oxyhemoglobin content in the veins before person loses consciousness. A telltale sign of inhalation or ingestion is the odor of bitter almonds on the breath, however up to half the population is genetically unable to detect this smell. Dialated pupils are common in severe poisonings. Contact with broken skin can cause cyanide absorption into the bloodstream. Cyanide ingestion can cause a bitter, burning taste, salivation, nausea, vomiting, anxiety, confusion, vertigo (dizziness), giddiness, sensation of stiffness in the lower jaw, and dyspnea (difficult respiration). In severe cases symptoms could progress to convulsions, paralysis, coma, cardiac arrhythmias, followed by death due to respiratory failure.
**Chronic Effects:** Chronic skin contact may cause cyanide rash, characterized by itching, and macular (blotches), papular (small, solid, conical, elevation of the skin), and vesicular (blister-like) eruptions. Chronic cyanide inhalation may cause appetite loss, headache, weakness, nausea, dizziness, and symptoms of irritation of the upper respiratory tract and eyes. Other symptoms of chronic exposure include goiter, B12 and folate abnormalities, chest discomfort, epistaxis (nose bleed), poor appetite and sleeping, and functional changes in hearing.
**FIRST AID:** *Emergency personnel should protect against contamination!*
**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
**Skin:** *Quickly* remove contaminated clothing. Speed is extremely important. Rinse with flooding amounts of water for at least 15 min. Wash exposed area *extremely thoroughly* with soap and water. If irritation and pain persist, consult a physician.
**Inhalation:** Remove exposed person to fresh air and immediately begin administering 100% oxygen. Avoid mouth-to-mouth resuscitaton during CPR to prevent self-poisonings.
**Ingestion:** Obtain and prepare the Lilly cyanide antidote kit [Eli Lilly Co. (Stock No. M76)] for use in symptomatic patients. Never give anything by mouth to an unconscious or convulsing person. Do not induce vomiting with Ipecac syrup. Consider gastric lavage. Activated charcoal is said to be ineffective.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Note to Physicians:** If the victim is unconscious, bradycardia and absence of cyanosis may be key diagnostic signs. Consider administration of amyl nitrite followed by sodium nitrite and sodium thiosulfate (antidote kit). Consider use of 100% oxygen.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Immediately notify safety personnel, isolate area, deny entry, and stay upwind. Shut off all ignition sources—no flames, flares, or smoking in hazard area. Cleanup personnel should wear fully encapsulating, vapor-protective clothing for spills or leaks without fire. For small dry spills, carefully scoop into clean, dry, suitable container and cover loosely. For small solution spill, take up with earth, sand, vermiculite, or other absorbent, noncombustible material and place in suitable containers. For large spills, dike far ahead of solution spills for later disposal. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
**EPA Designations**
Listed as a RCRA Hazardous Waste (40 CFR 261.33): Hazardous Waste No. P030
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity: *An RQ is not being assigned to the general class* [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Since contact lens use in industry is controversial, establish your own policy.
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Select the respirator based on its suitability provide adequate worker protection for the given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA with a full facepiece operated in pressure-demand or other positive-pressure mode. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent repeated or prolonged skin contact.
**Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Separate contaminated work clothes from street clothes. Launder contaminated work clothing before wearing. Remove this material from your shoes and clean personal protective equipment.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics. Cyanide detoxifying kits and instructions should be available in use areas. Instruct employees working in these areas on how and when to use these kits.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Avoid physical damage to containers. Store in tightly closed and properly labeled containers in cool, dry, well-ventilated area away from heat and incompatibles.
**Engineering Controls:** To reduce potential health hazards, use sufficient dilution or local exhaust ventilation to control hazardous airborne contaminants and to maintain concentrations at the lowest practical level.
**Other Precautions:** If respirators are used, implement a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Consider preplacement and periodic medical examinations of exposed workers that emphasize the heart, blood, and respiratory system.

**Transportation Data (49 CFR 172.101, .102)**

**DOT Shipping Name:** Cyanide *or* cyanide mixture, dry
**DOT Hazard Class:** Poison B
**ID No.:** UN1588
**DOT Label:** Poison
**DOT Packaging Exceptions:** 173.364
**DOT Packaging Requirements:** 173.370

**IMO Shipping Name:** Cyanides, inorganic, n.o.s.
**IMO Hazard Class:** 6.1
**ID No.:** UN1588
**IMO Label:** Poison
**IMDG Packaging Group:** I/II; Stow 'away from' acids

*MSDS Collection* References: 73, 101, 103, 126, 127, 136, 143, 146, 148, 153, 159, 161, 163
Prepared by: M Gannon, BA; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: AC Darlington, MPH, MD; Edited by: JR Stuart, MS

# 1,1-DICHLOROETHANE

DCH

| Common Synonyms | Oily liquid | Colorless | Chloroform like ethereal |
|---|---|---|---|
| Ethylidene chloride<br>Ethylidene dichloride<br>Chlorinated hydrochloric ether | Sinks and mixes with water. | | |

Wear goggles, self-contained breathing apparatus, and rubber overclothing (including gloves)
Stop discharge if possible. Keep people away.
Shut off ignition sources and call fire department.
Avoid contact with liquid.
Isolate and remove discharged material.
Notify local health and pollution control agencies.

**Fire**

Flammable.
POISONOUS GAS MAY BE PRODUCED IN FIRE OR WHEN HEATED.
Containers may explode in fire.
Wear goggles and self-contained breathing apparatus.
Extinguish with alcohol foam, carbon dioxide, or dry chemical.
Water may be ineffective on fire.

**Exposure**

CALL FOR MEDICAL AID.

LIQUID
If swallowed may cause nausea, vomiting and faintness.
Irritating to skin and eyes.
Flush affected areas with plenty of water.
IF IN EYES, hold eyelids open and flush with plenty of water.
IF SWALLOWED and victim is CONSCIOUS have victim drink water or milk and induce vomiting.

**Water Pollution**

Dangerous to aquatic life in high concentrations.
May be dangerous if it enters water intakes.

Notify local health and wildlife officials.
Notify operators of nearby water intakes.

## 1. RESPONSE TO DISCHARGE

(See Response Methods Handbook)

Issue warning-high flammability.
Restrict access.
Chemical and physical treatment.

## 2. LABEL

2.1 Category: None
2.2 Class: Not pertinent

## 3. CHEMICAL DESIGNATIONS

3.1 CG Compatibility Class: Halogenated hydrocarbon
3.2 Formula: $C_2H_4Cl_2$
3.3 IMO/UN Designation: Not listed
3.4 DOT ID No.: 2362
3.5 CAS Registry No.: 75-34-3

## 4. OBSERVABLE CHARACTERISTICS

4.1 Physical State (as shipped): Oily liquid
4.2 Color: Colorless
4.3 Odor: Chloroform

## 5. HEALTH HAZARDS

5.1 Personal Protective Equipment: In areas of poor ventilation or high concentration, a self-contained breathing apparatus with full face mask should be worn. Chemical workers goggles, rubber gloves, and protective clothing should be worn.
5.2 Symptoms Following Exposure: INHALATION: Irritation of respiratory tract. Salivation, sneezing, coughing, dizziness, nausea, and vomiting. EYES: Irritation, lacrimation, and reddening of conjunctiva. SKIN: Irritation. Prolonged or repeated skin contact can produce a slight burn. INGESTION: Ingestion incidental to industrial handling is not considered to be a problem. Swallowing of substantial amounts could cause nausea, vomiting, faintness, drowsiness, cyanosis, and circulatory failure.
5.3 Treatment of Exposure: Call a doctor. INHALATION: Remove from contaminated area; keep warm and quiet. If breathing has stopped, give artificial respiration. Administer oxygen. EYES: Flush with large amounts of water or weak bicarbonate of soda solution. SKIN: Dilute with large amounts of water. Remove contaminated clothing. INGESTION: Attempt to empty stomach; dilute by administering fluids (tap water, soapy water, salt water, or milk).
5.4 Threshold Limit Value: 200 ppm.
5.5 Short Term Inhalation Limits: 250 ppm.
5.6 Toxicity by Ingestion: Grade 2; $LD_{50}$ = 0.5 to 5 g/kg (rat).
5.7 Late Toxicity: Chronic exposure may cause liver damage and dermatitis. Animal experimentation has shown this compound to be slightly embryo-toxic and to retard fetal development.
5.8 Vapor (Gas) Irritant Characteristics: Vapors cause a slight smarting of the eyes or respiratory system if present in high concentrations. The effect is temporary.
5.9 Liquid or Solid Irritant Characteristics: Minimum hazard. If spilled on clothing and allowed to remain, may cause smarting and reddening of skin.
5.10 Odor Threshold: Data not available
5.11 IDLH Value: 4,000 ppm

## 6. FIRE HAZARDS

6.1 Flash Point: 57°F O.C. = 22°F C.C.
6.2 Flammable Limits in Air: 5.6% to 11.4%
6.3 Fire Extinguishing Agents: Alcohol foam, water, foam, $CO_2$, dry chemical, carbon tetrachloride
6.4 Fire Extinguishing Agents Not to be Used: Water may be ineffective
6.5 Special Hazards of Combustion Products: When heated to decomposition emits highly toxic fumes to phosgene.
6.6 Behavior in Fire: Explosion hazard
6.7 Ignition Temperature: 856°F
6.8 Electrical Hazard: Data not available
6.9 Burning Rate: Data not available
6.10 Adiabatic Flame Temperature: Data not available
6.11 Stoichiometric Air to Fuel Ratio: Data not available
6.12 Flame Temperature: Data not available

## 7. CHEMICAL REACTIVITY

7.1 Reactivity With Water: No reaction
7.2 Reactivity with Common Materials: Data not available
7.3 Stability During Transport: Data not available
7.4 Neutralizing Agents for Acids and Caustics: Data not available
7.5 Polymerization: Data not available
7.6 Inhibitor of Polymerization: Iable Data not available
7.7 Molar Ratio (Reactant to Product): Data not available
7.8 Reactivity Group: 36

## 8. WATER POLLUTION

8.1 Aquatic Toxicity:
$TL_m$ (Marine pinperch) 250 to 275 mg/l
24-hour $TL_m$ Brine shrimp: 320 mg/l
24-hour $TL_m$ Pinperch: 160 mg/l
8.2 Waterfowl Toxicity: Data not available
8.3 Biological Oxygen Demand (BOD): Percent, 0.05 g/g for 10 days Percent, 0.002 g/g for 5 days
8.4 Food Chain Concentration Potential: Data not available

## 9. SHIPPING INFORMATION

9.1 Grades of Purity: Data not available
9.2 Storage Temperature: Cool
9.3 Inert Atmosphere: Data not available
9.4 Venting: Data not available

## 10. HAZARD ASSESSMENT CODE

(See Hazard Assessment Handbook)

A-P-Q-R-S

## 11. HAZARD CLASSIFICATIONS

11.1 Code of Federal Regulations: Not listed
11.2 NAS Hazard Rating for Bulk Water Transportation: Not listed
11.3 NFPA Hazard Classification:

| Category | Classification |
|---|---|
| Health Hazard (Blue) | 2 |
| Flammability (Red) | 3 |
| Reactivity (Yellow) | 0 |

## 12. PHYSICAL AND CHEMICAL PROPERTIES

12.1 Physical State at 15°C and 1 atm: Liquid
12.2 Molecular Weight: 98.97
12.3 Boiling Point at 1 atm: 135.14°F = 57.3°C = 330.5°K
12.4 Freezing Point: −143.32°F = −97.4°C = 175.75°K
12.5 Critical Temperature: 502.7°F = 261.5°C = 534.65°K
12.6 Critical Pressure: 734.8 psia = 50 atm = 5.065 MN/m²
12.7 Specific Gravity: 1.174 at 20°C
12.8 Liquid Surface Tension: 24.75 dynes/cm = 0.02475 N/m at 20°C
12.9 Liquid Water Interfacial Tension: Data not available
12.10 Vapor (Gas) Specific Gravity: 3.42
12.11 Ratio of Specific Heats of Vapor (Gas): 1.136 at 20°C (68°F)
12.12 Latent Heat of Vaporization: 131.6 Btu/lb = 73.1 cal/g = $3.06 \times 10^4$ J/kg
12.13 Heat of Combustion: −4,774 Btu/lb = −2,652 cal/g = $-111 \times 10^4$ J/kg
12.14 Heat of Decomposition: Data not available
12.15 Heat of Solution: Data not available
12.16 Heat of Polymerization: Data not available
12.25 Heat of Fusion: Data not available
12.26 Limiting Value: Data not available
12.27 Reid Vapor Pressure: 7.35 psia

NOTES

DCH

# DICHLOROETHANE

### 12.17 SATURATED LIQUID DENSITY

| Temperature (degrees F) | Pounds per cubic foot |
|---|---|
| 35 | 75.198 |
| 40 | 74.929 |
| 45 | 74.660 |
| 50 | 74.389 |
| 55 | 74.120 |
| 60 | 73.851 |
| 65 | 73.580 |
| 70 | 73.311 |
| 75 | 73.042 |
| 80 | 72.771 |
| 85 | 72.502 |

### 12.18 LIQUID HEAT CAPACITY

| Temperature (degrees F) | British thermal unit per pound-F |
|---|---|
| | D |
| | A |
| | T |
| | A |
| | N |
| | O |
| | T |
| | A |
| | V |
| | A |
| | I |
| | L |
| | A |
| | B |
| | L |
| | E |

### 12.19 LIQUID THERMAL CONDUCTIVITY

| Temperature (degrees F) | British thermal unit-inch per hour-square foot-F |
|---|---|
| 35 | .804 |
| 40 | .799 |
| 45 | .795 |
| 50 | .791 |
| 55 | .786 |
| 60 | .782 |
| 65 | .778 |
| 70 | .773 |
| 75 | .769 |
| 80 | .765 |
| 85 | .760 |
| 90 | .756 |
| 95 | .752 |
| 100 | .747 |
| 105 | .743 |
| 110 | .739 |

### 12.20 LIQUID VISCOSITY

| Temperature (degrees F) | Centipoise |
|---|---|
| 35 | .617 |
| 40 | .595 |
| 45 | .574 |
| 50 | .555 |
| 55 | .537 |
| 60 | .520 |
| 65 | .504 |
| 70 | .489 |
| 75 | .475 |
| 80 | .462 |
| 85 | .449 |
| 90 | .437 |
| 95 | .426 |
| 100 | .415 |
| 105 | .405 |
| 110 | .395 |
| 115 | .386 |
| 120 | .377 |

### 12.21 SOLUBILITY IN WATER

| Temperature (degrees F) | Pounds per 100 pounds of water |
|---|---|
| 68 | .500 |

### 12.22 SATURATED VAPOR PRESSURE

| Temperature (degrees F) | Pounds per square inch |
|---|---|
| —70 | —1.334 |
| —60 | —1.944 |
| —50 | —.555 |
| —40 | .835 |
| —30 | .225 |
| —20 | .386 |
| —10 | .996 |
| 0 | 1.607 |
| 10 | 2.217 |
| 20 | 2.827 |
| 30 | 3.438 |
| 40 | 4.048 |
| 50 | 4.658 |
| 60 | 5.269 |
| 70 | 5.879 |
| 80 | 6.489 |
| 90 | 7.100 |
| 100 | 7.710 |
| 110 | 8.321 |
| 120 | 8.931 |
| 130 | 9.541 |

### 12.23 SATURATED VAPOR DENSITY

| Temperature (degrees F) | Pounds per cubic foot |
|---|---|
| —100 | .07407 |
| —80 | .05000 |
| —60 | .02594 |
| —40 | .00187 |
| —20 | .02219 |
| 0 | .04626 |
| 20 | .07032 |
| 40 | .09439 |
| 60 | .11845 |
| 80 | .14252 |
| 100 | .16658 |
| 120 | .19065 |
| 140 | .21471 |
| 160 | .23878 |

### 12.24 IDEAL GAS HEAT CAPACITY

| Temperature (degrees F) | British thermal unit per pound-F |
|---|---|
| | D |
| | A |
| | T |
| | A |
| | N |
| | O |
| | T |
| | A |
| | V |
| | A |
| | I |
| | L |
| | A |
| | B |
| | L |
| | E |

# Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 359
ETHYLENE DICHLORIDE
(Formerly 1,2-Dichloroethane)
(Revision C)
Issued: November 1978
Revised: August 1987

## SECTION 1. MATERIAL IDENTIFICATION

CHEMICAL NAME: ETHYLENE DICHLORIDE (Changed to reflect common industrial practice)

DESCRIPTION (Origin/Uses): Made from acetylene and HCl. Used as a degreaser, a scavenger in leaded gasoline, as an intermediate in the manufacture of vinyl chloride, in paint removers, in wetting and penetration agents, in ore flotation processes, as a fumigant, and as a solvent for fats, oils, waxes, and gums.

OTHER DESIGNATIONS: 1,2-Dichloroethane; *sym*-Dichloroethane; Dutch Liquid; Dutch Oil; EDC; Ethane Dichloride; Ethylene Chloride; 1,2-Ethylene Dichloride; Glycol Dichloride; $C_2H_4Cl_2$; NIOSH *RTECS* KI0525000; CAS #0107-06-2

MANUFACTURERS/SUPPLIERS: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640; Telephone: (517) 636-1000

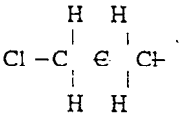
COMMENTS: Ethylene dichloride is a flammable, toxic liquid.


| HMIS | | | |
|---|---|---|---|
| H | 1 | R | 1 |
| F | 3 | I | 4 |
| R | 0 | S | 2 |
| PPE* | | K | 4 |

* See Sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS

| | % | HAZARD DATA |
|---|---|---|
| Ethylene Dichloride, CAS #0107-06-2; NIOSH *RTECS* #KI0525000 | 100 | ACGIH Values 1987-88<br>TLV-TWA: 10 ppm, 40 mg/m$^3$<br>OSHA PEL* 1986-87<br>8-Hr TWA: 50 ppm;<br>Ceiling: 100 ppm (15 Min.)<br>NIOSH REL 1986-87<br>10-Hr TWA: 1 ppm<br>Ceiling: 2 ppm (15 Min.)<br>Toxicity Data<br>Man, Inhalation, $TC_{Lo}$: 4000 ppm/1 Hr<br>Human, Oral, $TD_{Lo}$: 428 mg/kg<br>Man, Oral, $TD_{Lo}$: 892 mg/kg<br>Man, Oral, $LD_{Lo}$: 714 mg/kg<br>Rat, Oral, $LD_{50}$: 670 mg/kg |



*The maximum allowable peak concentration (above the ceiling level value) of ethylene dichloride is 200 ppm for 5 minutes in any 3-hour period.

COMMENTS: Additional data concerning toxic doses and tumorigenic, reproductive, and mutagenic effects is listed (with references) in the NIOSH *RTECS* 1983-84 supplement, pages 865-66.

## SECTION 3. PHYSICAL DATA

Boiling Point ... 182.3°F (83.5°C)
Vapor Pressure ... 87 Torr at 77°F (25°C)
Water Solubility ... Soluble in about 120 Parts Water
Vapor Density (Air = 1) ... 3.4
Evaporation Rate (n-BuAc = 1) ... Not Listed
Specific Gravity ... 1.2569 at 69°F (20°C)
Freezing Point ... -31.9°F (-35.5°C)
Molecular Weight ... 98.96 Grams/Mole

Appearance and odor: Colorless, clear liquid. Sweet, chloroformlike odor is typical of chlorinated hydrocarbons. The recognition threshold (100% of test panel) for ethylene dichloride is 40 ppm. Odor detection probably indicates an excessive exposure to vapor. High volatility and flammability, coupled with its toxicity and carcinogenic potential, make this material a major health hazard.

COMMENTS: Ethylene dichloride is miscible with alcohol, chloroform, and ether.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| See Below | 775°F (413°C) | % by Volume | 6.2 | 15.9 |

EXTINGUISHING MEDIA: Use chemical, carbon dioxide, alcohol foam, water spray/fog, or dry sand to fight fires involving ethylene dichloride. Direct water sprays may be ineffective extinguishing agents, but they may be successfully used to cool fire-exposed containers. Use a smothering effect to extinguish fires involving this material. UNUSUAL FIRE/EXPLOSION HAZARDS: Ethylene dichloride is a dangerous fire and explosion hazard when exposed to sources of ignition such as heat, open flames, sparks, etc. Its vapors are heavier than air and can flow along surfaces to distant, low-lying sources of ignition and flash back. If it is safe to do so, remove this material from the fire area. Ethylene dichloride burns with a smoky flame.

SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode.

COMMENTS: Flash Point and Method: 56°F (13°C) CC; 65°F (18°C) OC.

OSHA Flammability Class (29 CFR 1910.106): IB. DOT Flammability Class (49 CFR 173.115): Flammable Liquid

## SECTION 5. REACTIVITY DATA

Ethylene dichloride is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES include strong oxidizing agents. Explosions have occurred with mixtures of this material and liquid ammonia or dimethylaminopropylamine. Finely divided aluminum or magnesium metal may be hazardous in contact with ethylene dichloride.

CONDITIONS TO AVOID: Eliminate sources of ignition such as excessive heat, open flames, or electrical sparks, particularly in low-lying areas, because the explosive, heavier-than-air vapors will concentrate there.

PRODUCTS OF HAZARDOUS DECOMPOSITION can include vinyl chloride, chloride fumes, and phosgene. Phosgene is an extremely poisonous gas. Products of thermal-oxidative degradation (i.e., fire conditions) must be treated with appropriate caution.

## SECTION 6. HEALTH HAZARD INFORMATION

Ethylene dichloride is listed as an anticipated human carcinogen by the NTP and as a probable human carcinogen (Group 2B), by the IARC. It was found to be an animal-positive carcinogen by the IARC. NCI reported positive results (mouse, rat) from its carcinogenesis bioassay. SUMMARY OF RISKS: Ethylene dichloride is considered to be one of the more toxic of the common chlorinated hydrocarbons. Deaths from accidental ingestion of this material have been reported. Inhalation of vapors reportedly caused three fatalities. Excessive inhalation of ethylene dichloride vapors can cause respiratory irritation, intoxication, narcotic and anesthetic effects, vomiting, dizziness, depression, and diarrhea. The hepatoxic (injurious to liver) effects of this material are significant. The systemic effects from overexposure can appear in the liver, kidneys, digestive tract, blood, lungs, adrenal glands, and the central nervous system. Tests on animals have revealed reproductive failure and fetal resorption. There may be increased risk to nursing infants of exposed mothers. TARGET ORGANS: Central nervous system, eyes, kidneys, liver, heart, adrenal glands, and skin. PRIMARY ENTRY: Inhalation, absorption through skin, oral, or eye contact. ACUTE EFFECTS: Skin contact causes irritation, defatting, and, if repeated or prolonged, burning. Eye contact causes irritation and serious injury (clouding of the cornea) if it is not removed promptly. CHRONIC EFFECTS: Injuries to the liver (hepatoxicity) and kidneys, weight loss, low blood pressure, jaundice, oliguria (reduced excretion of urine), or anemia. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Persons taking anticoagulants could experience an increase in tendency to bleed. Persons taking insulin face an increased risk of lowered blood sugar. FIRST AID: Be prepared to restrain a hyperactive victim. EYE CONTACT: Flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Immediately flush the affected area with water. Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Get medical help.* INGESTION: Never give anything by mouth to someone who is unconscious or convulsing. Rinse victim's mouth with water. Oxygen and artificial respiration may be needed. Get medical help.* * GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Before using ethylene dichloride, it is essential that proper emergency procedures be established and made known to all personnel involved in handling it. Notify safety personnel of ethylene dichloride spills or leaks and implement containment procedures. Remove and eliminate all possible sources of ignition such as heat, sparks, and open flames from the area. Cleanup personnel should use protection against inhalation of vapors and contact with liquid. Contain spills by using an absorbent material such as dry sand or vermiculite. Use nonsparking tools to mix waste material thoroughly with absorbent and place it in an appropriate container for disposal. Flush trace residues with large amounts of water. Do not flush waste to sewers or open waterways. WASTE DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill. Waste may be burned in an approved incinerator equipped with an afterburner and a scrubber. Follow Federal, state, and local regulations.

Ethylene dichloride is designated as a hazardous substance by the EPA (40 CFR 116.4). Ethylene dichloride is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U077

EPA Reportable Quantity (40 CFR 117.3): 5000 lbs (2270 kgs)

Aquatic Toxicity Rating, TLm 96: 1000 - 100 ppm

## SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Ethylene dichloride is particularly harmful to the eyes, and direct contact results in corneal opacity (permanent clouding of the eye). GLOVES: Wear impervious rubber gloves to prevent skin contact. RESPIRATOR: Use a NIOSH-approved respirator per the NIOSH *Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of ethylene dichloride requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. Warning: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER: Wear rubber boots, aprons, and other protective clothing suitable for use conditions to prevent skin contact. Remove contaminated clothing and launder it before wearing it again. Discard contaminated shoes. VENTILATION: Provide maximum explosion-proof local fume exhaust ventilation systems to maintain the airborne concentrations of ethylene dichloride vapors below the exposure limits cited in section 2. Install properly designed hoods that maintain a minimum face velocity of 100 lfm (linear feet per minute). SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. SPECIAL CONSIDERATIONS: Vapors are heavier than air and will collect in low-lying areas. Eliminate sources of ignition in these areas and again provide good ventilation there. COMMENTS: Practice good personal hygiene. Keep materials off of your clothes and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Immediately remove ethylene dichloride-saturated clothing to avoid flammability and health hazards. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store ethylene dichloride in tightly closed containers in a cool, dry, well-ventilated area away from sources of ignition. Protect containers from physical damage and from exposure to excessive heat. Avoid direct physical contact with strong acids, bases, oxidizing agents, and reducing agents. SPECIAL HANDLING/STORAGE: Use nonsparking tools. Outside or detached storage is preferred. Store and handle ethylene dichloride in accordance with the regulations concerning OSHA class IB flammable liquids. ENGINEERING CONTROLS: During transfer operations involving ethylene dichloride, the liquid and its vapors must not be exposed to nearby sources of ignition from engineering systems that are not explosion proof. Preplan emergency response procedures.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: Flammable Liquid

DOT Label: Flammable Liquid

IMO Class: 3.2

DOT Shipping Name: Ethylene Dichloride

DOT ID No. UN 1184

IMO Label: Flammable Liquid, Poison

References: 1-9, 12, 19, 21, 26, 43, 47, 73, 87-102. CK





Approvals JO. Rennello

Indust. Hygiene/Safety

Medical Review Geoff Goldsmith MD

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*Material Safety Data Sheets Collection:*

Sheet No. 703
**1,2-Dichloroethylene**

Issued: 4/90

## Section 1. Material Identification 31

**1,2-Dichloroethylene Description:** An industrial solvent composed of 60% cis- and 40% trans-isomers. Both isomers, cis and trans, are made by partial chlorination of acetylene. Used as a general solvent for organic materials, lacquers, dye extraction, thermoplastics, organic synthesis, and perfumes. The trans-isomer is more widely used in industry than either the cis-isomer or the mixture. Toxicity also varies between the two isomers.

**Other Designations:** CAS No. 0540-59-0; $C_2H_2Cl_2$; acetylene dichloride; *cis*-1,2-dichloroethylene; *sym*-dichloroethylene; *trans*-1,2-dichloroethylene, dioform.

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

R 1
I 2
S 2
K 1

NFPA


HMIS
H 2
F 3
R 1
PPG*
* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

1,2-Dichloroethylene, ca 100%

**OSHA PEL**
8-hr TWA: 790 mg/m³, 200 ppm

**ACGIH TLV, 1989-90**
TLV-TWA: 790 mg/m³, 200 ppm

**NIOSH REL, 1987**
790 mg/m³, 200 ppm

**Toxicity Data***
Rat, oral, $LD_{50}$: 770 mg/kg; toxic effects not yet reviewed
Frog, inhalation, $TC_{Lo}$: 117 mg/m³ inhaled for 1 hr affects the peripheral nerve and sensation (flaccid paralysis without anesthesia); behavior (excitement); lungs, thorax, or respiration (respiratory depression)

* See NIOSH, *RTECS* (KV9360000), for additional toxicity data.

## Section 3. Physical Data

**Boiling Point:** 119 °F/48 °C
**Melting Point:** -56 to -115 °F/-49 to -82 °C/
**Vapor Pressure:** 180 to 264 torr at 68 °F/20 °C
**Vapor Density (Air = 1):** 3.4

**Molecular Weight:** 96.95 g/mol
**Specific Gravity ($H_2O$ = 1 at 39 °F/4 °C):** 1.27 at 77 °F/25 °C
**Water Solubility:** Insoluble

**Appearance and Odor:** A colorless, low-boiling liquid with a pleasant odor.

## Section 4. Fire and Explosion Data

| Flash Point: 37 °F/2.8 °C, CC | Autoignition Temperature: 860 °F/460 °C | LEL: 5.6% v/v | UEL: 12.8% v/v |
|---|---|---|---|

**Extinguishing Media:** Use dry chemical, $CO_2$, halon, water spray, or standard foam. Water may be ineffective unless used to blanket the fire.
**Unusual Fire or Explosion Hazards:** This material's vapors are a dangerous fire hazard and moderate explosion hazard when exposed to any heat or ignition source or oxidizer.
**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and a fully encapsulating suit. Vapors may travel to heat or ignition sources and flash back. Stay upwind and out of low areas. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** This material is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** This material is incompatible with alkalies, nitrogen tetraoxide, difluoromethylene, strong oxidizers, and dihypofluorite. When in contact with copper or copper alloys or by reaction with potassium hydroxide, explosive chloroacetylene may be released.
**Conditions to Avoid:** Addition of hot liquid to cold 1,2-dichloroethylene may cause sudden emission of vapor that could flash back to an ignition source.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of 1,2-dichloroethylene can produce highly toxic fumes of chlorine ($Cl^-$).

## Section 6. Health Hazard Data

**Carcinogenicity:** Neither the NTP, IARC, nor OSHA lists 1,2-dichloroethylene as a carcinogen.

**Summary of Risks:** 1,2-Dichloroethylene's most important effect is its irritation of the central nervous system (CNS) and narcosis. This material is toxic by inhalation, ingestion, and skin contact. It is also irritating to the eyes. The trans-isomer at 2200 ppm causes nausea, vertigo, and burning of the eyes. The trans-isomer is twice as potent as the cis-isomer. If renal effects occur, they are transient.

**Medical Conditions Aggravated by Long-Term Exposure:** None reported.

**Target Organs:** Central nervous system, eyes, respiratory system.

**Primary Entry Routes:** Inhalation, ingestion, skin and eye contact.

**Acute Effects:** Inhalation of 1,2-dichloroethylene causes narcosis, respiratory tract irritation, nausea, vomiting, tremor, weakness, central nervous depression, and epigastric (the abdomen's upper midregion) cramps. Contact with the liquid causes eye and skin (on prolonged contact) irritation. Ingestion causes slight depression to deep narcosis.

**Chronic Effects:** None reported.

FIRST AID

**Eyes:** Flush immediately, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 min.

**Skin:** *Quickly* remove contaminated clothing. After rinsing affected skin with flooding amounts of water, wash it with soap and water.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed. Have trained personnel administer 100% oxygen, preferably with humidification.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, have a *conscious* person drink 1 to 2 glasses of water, then induce repeated vomiting until vomit is clear.

**After first aid, get appropriate in-plant, paramedic, or community medical support.**

**Physician's Note:** Intravenous injections of calcium gluconate may relieve cramps and vomiting. Treat central nervous system effects symptomatically.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** *Design and practice a 1,2-dichloroethylene spill control and countermeasure plan (SCCP).* Notify safety personnel, remove all heat and ignition sources, evacuate hazard area, and provide adequate ventilation. Cleanup personnel should protect against vapor inhalation and skin or eye contact. Absorb small spills on paper towels. After evaporating the 1,2-dichloroethylene from these paper towels in a fume hood, burn the paper in a suitable location away from combustible material. Collect and atomize large quantities in a suitable combustion chamber equipped with an appropriate effluent gas cleaning device. Follow applicable OSHA regulations (29 CFR 1910.120).

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations**

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 100 lb (45.4 kg) [* per RCRA, Sec. 3001, per Clean Water Act, Sec. 307(a)]†

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1)

† Listed as 1,2-*trans*-dichloroethylene.

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA.

**Warning:** Air-purifying respirators do *not* protect workers in oxygen-deficient atmospheres.

**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. 1,2-dichloroethylene attacks some forms of plastics, rubber, and coatings.

**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in tightly closed containers in a cool, well-ventilated area away from all incompatible materials (Sec. 5) and oxidizing materials. Outside or detached storage is preferred. If stored inside, place containers in a standard flammable liquids storage cabinet or room. Protect containers from physical damage.

**Engineering Controls:** Avoid vapor inhalation and skin and eye contact. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. 1,2-dichloroethylene is a dangerous fire hazard. All engineering systems should be of maximum explosion-proof design and electrically grounded and bonded. Provide preplacement questionnaires which emphasize detecting a history of chronic respiratory disease.

**Transportation Data (49 CFR 172.101, .102):** Not listed

*MSDS Collection* **References:** 7, 26, 38, 73, 84, 85, 87, 88, 100, 101, 103, 109, 126, 127, 136, 137

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD

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*Material Safety Data Sheets Collection:*

**Sheet No. 414**
**Di(2-ethylhexyl)phthalate**

Issued: 12/84 Revision: A, 11/90

## Section 1. Material Identification 33

**Di(2-ethylhexyl)phthalate ($C_{24}H_{38}O_4$) Description:** Prepared by acid-catalyzed reaction of 2-ethylhexanol with phthalic anhydride. Used in plasticizing a variety of polymeric materials such natural rubber, synthetic rubber, nitrocellulose, ethyl cellulose, cellulose acetate butyrate, polymethyl methacrylate, polyvinyl butyral, polyvinylidine chloride, and polystyrene; as an organic pump fluid; as a testing agent for air filtration systems, a component of dielectric fluids in electrical capacitors, an inert ingredient in pesticide formulations; in liquid soaps, detergents, rubbing alcohol, decorative inks, lacquers, photographic film, wire and cable, adhesives, industrial and lubricating oils, munitions, and defoaming agents used during paper and paperboard manufactures.

**Other Designations:** CAS No. 0117-81-7, 1, 2-benzenedicarboxylic acid bis(2-ethylhexyl) ester, DEHP, di-sec-octyl phthalate, dioctyl phthalate, DOP, octyl phthalate.

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

**Cautions:** Di(2-ethylhexyl)phthalate is a possible human carcinogen. Di(2-ethylhexyl)phthalate is a mild skin, eye, and mucous membrane irritant. It affects the gastrointestinal (GI) tract.

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| I | 2 |
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| K | 1 |

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F 1
R 0
PPG*
* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Di(2-ethylhexyl)phthalate, ca 100%

**1989 OSHA PEL**
8-hr TWA: 5 mg/m³

**1990-91 ACGIH TLVs**
TWA: 5 mg/m³
STEL: 10 mg/m³

**1988 NIOSH REL**
Reduce to lowest feasible limit

**1985-86 Toxicity Data***
Man, oral, $TD_{Lo}$: 143 mg/kg ingested produces gastrointestinal effects
Rat, oral, $LD_{50}$: 30600 mg/kg
Rabbit, skin, $LD_{50}$: 25 gm/kg; toxic effects not yet reviewed

* See NIOSH, *RTECS* (TI0350000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 446 °F (230 °C) at 5 mm Hg
**Melting Point:** -58 °F (-50 °C)
**Vapor Pressure:** 1.32 mm Hg at 392 °F (200 °C)
**Vapor Density (Air = 1):** 16
1 ppm = ~15.94 mg/m³
**Appearance and Odor:** Light colored liquid with a slight odor.

**Molecular Weight:** 390.54
**Specific Gravity (20°C/20°C):** 0.9861
**Water Solubility:** <0.01% in water at 77 °F (25 °C)
**Viscosity:** 81.4 centipoise at 20 °C
**Pour Point:** -50.8 °F (-46 °C); 8.2 lb/gal at 20 °C

## Section 4. Fire and Explosion Data

| Flash Point: 420 °F (215 °C), OC | Autoignition Temperature: 735 °F (390 °C) | LEL: 0.3% v/v at 474 °F (245 °C) | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Use dry powder, carbon dioxide, or foam to fight a fire involving di(2-ethylhexyl)phthalate. Water or foam may cause frothing.

**Unusual Fire or Explosion Hazards:** This material offers no unusual fire hazards beyond those encountered with ordinary combustible materials.

**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Di(2-ethylhexyl)phthalate is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** This OSHA Class III-B combustible liquid is incompatible with strong oxidizing agents.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of di(2-ethylhexyl)phthalate can produce acrid smoke and fumes including carbon dioxide and carbon monoxide.

## Section 6. Health Hazard Data

**Carcinogenicity:** The NTP and IARC list di(2-ethylhexyl)phthalate as an anticipated human carcinogen and possible human carcinogen (Group 2B), respectively. Experimental studies show that di(2-ethylhexyl)phthalate has teratogenic effects in laboratory animals.

**Summary of Risks:** Di(2-ethylhexyl)phthalate is a mild skin and eye irritant. It affects the human gastrointestinal tract since it is absorbed intact from the gastrointestinal tract. However, when administered either intravenously or orally, it is rapidly metabolized to derivatives excreted mainly in urine or bile. Central nervous system (CNS) depression may occur, especially with ingestion of large amounts. Skin sensitization does not occur in humans. Inhalation of any significant amount is probably unlikely due to the low vapor pressure. Di(2-ethylhexyl)phthalate has become an environmental contaminant that may accumulate in the food chain.

**Medical Conditions Aggravated by Long-Term Exposure:** None reported.

**Target Organs:** Eyes, upper respiratory system, skin, central nervous system.

**Primary Entry Routes:** Inhalation, ingestion.

**Acute Effects:** Symptoms of overexposure include conjunctivitis, keratitis (inflammation of the eye's cornea), bronchial irritation, eczema, staggering, abdominal cramps, nausea, and diarrhea. CNS depression—lethargy, drowsiness, staggering, and sleepiness—can result from absorbing large amounts.

**Chronic Effects:** None reported.

**FIRST AID**

**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.

**Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed.

**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If ingested, *do not induce vomiting*. Consult a physician immediately.

**After first aid, get appropriate in-plant, paramedic, or community medical support.**

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel. Contain and pick up spilled material with some noncombustible absorbent material. For large spills, dike far ahead to contain. Place in appropriate containers for disposal. Prevent losses into the environment whenever possible. Do not release to sewers or waterways. This material degrades in fresh water sediments under aerobic conditions; half-life is ~14 days. It does not degrade under anaerobic conditions. It is readily concentrated by aquatic organisms. Clean up trace residues with water and detergent. Follow applicable OSHA regulations (29 CFR 1910.120).

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations**

Listed as a RCRA Hazardous Waste (40 CFR 261.33); Waste No. U028

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.45 kg) [* per RCRA, Sec. 3001]

SARA Extremely Hazardous Substance (40 CFR 355): Not listed

SARA Toxic Chemical (40 CFR 372.65): Not listed

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact.

**Ventilation:** Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLVs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in closed containers in a well-ventilated area away from oxidizing agents and heat and ignition sources. To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations in production and storage areas.

**Engineering Controls:** Avoid prolonged or repeated contact with liquid and inhalation of mist or vapors. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.

**Transportation Data (49 CFR 172.101, .102):** Not listed

*MSDS Collection* References: 1-12, 14, 23, 38, 47, 73, 101, 103, 124, 126, 127, 132, 133, 136, 138, 143, 146

**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** AC Darlington, MD; **Edited by:** JR Stuart, MS

# Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 385

ETHYL BENZENE
(Revision A)
Issued: August 1978
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION 27

**Material Name:** ETHYL BENZENE

**Description (Origin/Uses):** Used as a solvent and as an intermediate in the production of styrene monomer.

**Other Designations:** Phenylethane; Ethylbenzol; $C_2H_5C_6H_5$; CAS No. 0100-41-4

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.


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*See sect. 8

R 1
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## SECTION 2. INGREDIENTS AND HAZARDS

| | % | EXPOSURE LIMITS |
|---|---|---|
| Ethyl Benzene, CAS No. 0100-41-4 | Ca 100 | **OSHA PELs**<br>8-Hr TWA: 100 ppm, 435 mg/m³<br>15- Min STEL: 125 ppm, 545 mg/m³<br>**ACGIH TLVs, 1988-89**<br>TLV-TWA: 100 ppm, 435 mg/m³<br>TLV-STEL: 125 ppm, 545 mg/m³<br>**Toxicity Data***<br>Human, Inhalation, $TC_{Lo}$: 100 ppm (8 Hrs)<br>Rat, Oral, $LD_{50}$: 3500 mg/kg |

*See NIOSH, *RTECS* (DA0700000), for additional data with references to reproductive, irritative, and mutagenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 277°F (136°C)
**Melting Point:** -139°F (-95°C)
**Vapor Pressure:** 7.1 Torrs at 68°F (20°C)
**Vapor Density (Air = 1):** 3.7
**% Volatile by Volume:** Ca 100

**Molecular Weight:** 106 Grams/Mole
**Solubility in Water (%):** Slight
**Specific Gravity ($H_2O$ = 1):** 0.86258 at 77°F (25°C)

**Appearance and Odor:** A clear, colorless, flammable liquid; characteristic aromatic hydrocarbon odor.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method: 64°F (18°C) CC | Autoignition Temperature: 810°F (432.22°C) | LEL: 1% v/v | UEL: 6.7% v/v |
|---|---|---|---|

**Extinguishing Media:** Use foam, dry chemical, or carbon dioxide to put out ethyl benzene fires. A water spray may be ineffective in extinguishing the fire, because it can scatter and spread the burning liquid. Use water spray to cool fire-exposed containers of ethyl benzene, to disperse ethyl benzene vapor, and to protect personnel attempting to stop an ethyl benzene leak. **Unusual Fire or Explosion Hazards:** This liquid can readily form explosive vapor-air mixtures, especially when heated. Ethyl benzene vapor is heavier than air and may travel a considerable distance to a low-lying source of ignition and flash back to its origin. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

**Stability/Polymerization:** Ethyl benzene is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Hazardous chemical reactions can occur between ethyl benzene and strong oxidizing agents, acids, ammonia, and bases. **Conditions to Avoid:** Avoid any exposure to sources of ignition such as heat, sparks, open flame, and lighted tobacco products, etc., and to incompatible chemicals. Use caution when entering confined spaces, particularly low-lying areas where explosive concentrations of ethyl benzene vapor may be present. Provide good ventilation to such areas to prevent the concentration of this vapor. **Hazardous Products of Decomposition:** Thermal-oxidative degradation can include toxic gases such as carbon monoxide and/or aromatic hydrocarbon gases.

## SECTION 6. HEALTH HAZARD INFORMATION

**Carcinogenicity:** Ethyl benzene is not listed as a carcinogen by the NTP, IARC, or OSHA.
**Summary of Risks:** Ethyl benzene vapor is severely irritating to the eyes and to the mucous membranes of the respiratory system. Sustained inhalation of excessive levels can cause depression of the central nervous system (CNS) characterized by dizziness, headache, narcosis, and coma. Skin contact with liquid ethyl benzene causes irritation; dermatitis and defatting can also develop. The acute oral toxicity of ethyl benzene is low; however, ingestion of it presents a serious aspiration hazard. Aspirating even a small amount into the lungs can result in extensive edema (lungs filled with fluid) and hemorrhaging of the lung tissue. No systemic effects are expected at the levels that produce pronounced, unignorable, disagreeable skin and eye irritation. The TLVs cited in section 2 are set to prevent this intolerable irritation. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, and CNS. **Primary Entry:** Inhalation, skin contact **Acute Effects:** Irritation of the skin, eyes, and respiratory system. Also, cardiac-rhythm disturbance due to sensitization; acute bronchitis, bronchospasm, pulmonary and laryngeal edema; euphoria; headache; giddiness; dizziness; and incoordination, as well as possible depression; confusion; and coma. **Chronic Effects:** None reported. **First Aid:** Eyes. Immediately

## SECTION 6. HEALTH HAZARD INFORMATION, cont.

flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with plenty of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, the aspiration hazard must be considered. Do not induce vomiting unless directed to do so by a physician. To prevent aspiration by spontaneous vomiting, keep the victim's head low (between his or her knees). **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Professional judgment is required as to whether or not to induce vomiting because of the possibility of aspiration. A gastric lavage may be administered, followed by saline catharsis, if this procedure is appropriate to the specific incident. Monitor cardiac and pulmonary functions.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).

**EPA Designations (40 CFR 302.4)**

CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), §§ 311 (b) (4) and 307 (a).

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Wear a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale ethyl benzene vapor.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store ethyl benzene in closed containers in a cool, dry, well-ventilated area away from sources of ignition and strong oxidizers. Protect containers from physical damage. **Special Handling/Storage:** Outside, isolated, detached, or remote storage is recommended for large quantities of ethyl benzene. Isolate bulk storage areas from acute fire hazards. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. To prevent static sparks, electrically ground and bond all containers, pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations. **Other:** Use safety cans for transferring small amounts of ethyl benzene.

**Transportation Data (49 CFR 172.101-2)**

**DOT Shipping Name:** Ethyl Benzene
**DOT Hazard Class:** Flammable Liquid
**ID No.** UN1175
**DOT Label:** Flammable Liquid
**DOT Packaging Exceptions:** 49 CFR 173.118
**DOT Packaging Requirements:** 49 CFR 173.119

**IMO Shipping Name:** Ethylbenzene
**IMO Hazard Class:** 3.2
**IMO Label:** Flammable Liquid
**IMDG Packaging Group:** II

**References:** 1, 26, 38, 84-94, 100, 116, 117, 120, 122.





Prepared by PJ Igoe, BS
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Medical Review: W Silverman, MD

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*Material Safety Data Sheets Collection:*

Sheet No. 713
Lead (Inorganic)

Issued: 8/90

## Section 1. Material Identification

**Lead (Inorganic) (Pb) Description:** Exists widely throughout the world in a number of ores. Its main commercial source is galena (lead sulphide). Lead mineral is separated from crude ores by blast-furnace smelting, drossing, or electrolytic refining. Lead is used mostly in manufacturing storage batteries. Other uses are in manufacturing tetraethyllead and both organic and inorganic lead compounds in ceramics, plastics, and electronic devices; in producing ammunition, solder, cable covering, sheet lead, and other metal products (brass, pipes, caulking); in metallurgy; in weights and as ballast; as a chemical intermediate for lead alkyls and pigments; as a constuction material for the tank linings, piping, and equipment used to handle the corrosive gases and liquids used in sulfuric acid manufacturing, petroleum refining, halogenation, sulfonation, extraction, and condensation; and for x-ray and atomic radiation protection.

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**Other Designations:** CAS No. 7439-92-1, lead oxide; lead salts, inorganic; metallic lead; plumbum.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

**Cautions:** *Inorganic lead is a potent systemic poison.* Organic lead (for example, tetraethyl lead) has severe, but different, health effects. Occupational lead poisoning is due to inhalation of dust and fumes. Major affected organ systems are the nervous, blood, and reproductive systems, and kidneys. Health impairment or disease may result from a severe acute short- or long-term exposure.

* Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Lead (inorganic) fumes and dusts, as Pb, ca 100%

**1989 OSHA PELs (Lead, inorganic compounds)**
8-hr TWA: 50 µg/m³
Action Level TWA*: 30 µg/m³

**29 CFR 1910.1025 Lead Standard**
Blood Lead Level: 40 µg/100 g

**1989-90 ACGIH TLV (Lead, inorganic, fumes and dusts)**
TLV-TWA: 150 µg/m³

**1988 NIOSH REL**
10-hr TWA: <100 µg/m³

**1985-86 Toxicity Data†**
Human, inhalation, $TC_{Lo}$: 10 µg/m³ affects gastrointestinal tract and liver
Human, oral, $TD_{Lo}$: 450 mg/kg ingested over 6 yr affects peripheral and central nervous systems
Rat, oral, $TD_{Lo}$: 790 mg/kg affects multigeneration reproduction

* Action level applies to employee exposure without regard to respirator use.
† See NIOSH, *RTECS* (OF7525000), for additional mutative, reproductive, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 3164 °F (1740 °C)
**Melting Point:** 621.3 °F (327.4 °C)
**Vapor Pressure:** 1.77 mm Hg at 1832 °F (1000 °C)
**Viscosity:** 3.2 cp at 621.3 °F (327.4 °C)
**Molecular Weight:** 207.20
**Specific Gravity (20 °C/4 °C):** 11.34
**Water Solubility:** Relatively insoluble in hot or cold water*
**Appearance and Odor:** Bluish-white, silvery, gray, very soft metal.

* Lead dissolves more easily at a low pH.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Use dry chemical, carbon dioxide, water spray, or foam to extinguish fire.
**Unusual Fire or Explosion Hazards:** Flammable and moderately explosive in the form of dust when exposed to heat or flame.
**Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Lead is stable at room temperature in closed containers under normal storage and handling conditions. It tarnishes on exposure to air. Hazardous polymerization cannot occur.
**Chemical Incompatibilities:** Mixtures of hydrogen peroxide + trioxane explode on contact with lead. Lead is incompatible with sodium azide, zirconium, disodium acetylide, and oxidants. A violent reaction on ignition may occur with concentrated hydrogen peroxide, chlorine trifluoride, sodium acetylide (with powdered lead), ammonium nitrate (below 200 °C with powdered lead). Lead is attacked by pure water and weak organic acids in the presence of oxygen. Lead is resistant to tap water, hydrofluoric acid, brine, and solvents.
**Conditions to Avoid:** Rubber gloves containing lead may ignite in nitric acid.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of lead can produce highly toxic fumes of lead.

## Section 6. Health Hazard Data

**Carcinogenicity:** Although the NTP and OSHA do not list lead as a carcinogen, the IARC lists it as probably carcinogenic to humans, but having (usually) no human evidence. However, the literature reports instances of lead-induced neoplasms, both benign and malignant, of the kidney and other organs in laboratory rodents. Excessive exposure to lead has resulted in neurologic disorders in infants. Experimental studies show lead has reproductive and teratogenic effects in laboratory animals. Human male and female reproductive effects are also documented.
**Summary of Risks:** Lead is a potent, systemic poison that affect a variety of organ systems, including the nervous system, kidneys, reproductive system, blood formation, and gastrointestinal (GI) system. The most important way lead enters the body is through inhalation, but it can also be ingested when lead dust or unwashed hands contaminate food, drink, or cigarettes. Much of ingested lead passes through feces without absorption into the body. Adults may absorb only 5 to 15% of ingested lead; children may absorb a much larger fraction. Once in the body, lead enters the bloodstream and circulates to various organs. Lead concentrates and remains in bone for many years. The amount of lead the body stores increases as exposure continues, with possibly cumulative effects. Depending on the dose entering the body, lead can be deadly within several days or affect health after many years. Very high doses can cause brain damage (encephalopathy).
**Medical Conditions Aggravated by Exposure:** Lead may aggravate nervous system disorders (e.g., epilepsy, neuropathies), kidney diseases, high blood pressure (hypertension), infertility, and anemia. Lead-induced anemia and its effect on blood presssure can aggravate cardiovascular disease.

*Continue on next page*

## Section 6. Health Hazard Data, *continued*

**Target Organs:** Blood, central and peripheral nervous systems, kidneys, and gastrointestinal (GI) tract.
**Primary Entry Routes:** Inhalation, ingestion.
**Acute Effects:** An acute, short-term dose of lead could cause acute encephalopathy with seizures, coma, and death. However, short-term exposures of this magnitude are rare. Reversible kidney damage can occur from acute exposure, as well as anemia.
**Chronic Effects:** Symptoms of chronic long-term overexposure include appetite loss, nausea, metallic taste in the mouth, lead line on gingival (gum) tissue, constipation, anxiety, anemia, pallor of the face and the eye grounds, excessive tiredness, weakness, insomnia, headache, nervous irritability, fine tremors, numbness, muscle and joint pain, and colic accompanied by severe abdominal pain. Paralysis of wrist and, less often, ankle extensor muscles may occur after years of increased lead absorption. Kidney disease may also result from chronic overexposure, but few, if any, symptoms appear until severe kidney damage has occurred. Reproductive damage is characterized by decreased sex drive, impotence, and sterility in men; and decreased fertility, abnormal menstrual cycles, and miscarriages in women. Unborn children may suffer neurologic damage or developmental problems due to excessive lead exposure in pregnant women. Lead poisoning's severest result is encephalopathy manifested by severe headache, convulsions, coma, delirium, and possibly death.
**FIRST AID**
**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
**Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Consult a physician if any health complaints develop.
**Inhalation:** Remove exposed person to fresh air and support breathing as needed. Consult a physician.
**Ingestion:** Never give anything by mouth to an unconscious or convulsing person. If large amounts of lead were ingested, induce vomiting with Ipecac syrup. Consult a physician immediately.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Physician's Note:** For diagnosis, obtain blood pressure, blood lead level (PbB), zinc protoporphyrin (ZPP), complete blood count for microcytic anemia and basophilic stippling, urinalysis, and blood urea nitrogen (BUN) of creatinine. Examine peripheral motor neuropathy, pallor, and gingival lead line. Use Ca-EDTA to treat poison, but *never* chelate prophylactically. Consult an occupational physician or toxicologist.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel and evacuate all unnecessary personnel immediately. Cleanup personnel should protect against inhalation of dusts or fume and contact with skin or eyes. Avoid creating dusty conditions. Water sprays may be used in large quantities to prevent the formation of dust. Cleanup methods such as vacuuming (with an appropriate filter) or wet mopping minimizes dust dispersion. Scoop the spilled material into closed containers for disposal or reclamation. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
**EPA Designations**
Listed as a RCRA Hazardous Waste (40 CFR 261.33, Appendix II—EP Toxicity Test Procedures)
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. Protective clothing made of man-made fibers and lacking turn-ups, pleats, or pockets retain less dust from lead.
**Ventilation:** Provide general and local ventilation systems to maintain airborne concentrations below the OSHA PELs (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially washing hands before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in tightly closed containers in a cool, dry, well-ventilated area away from all incompatible materials, direct sunlight, and heat and ignition sources.
**Engineering Controls:** Educate worker about lead's hazards. Follow and inform employees of the lead standard (29 CFR 1910.1025). Avoid inhalation of lead dust and fumes and ingestion of lead. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Avoid creating dusty conditions. Segregate and launder contaminated clothing. Take precautions to protect laundry personnel. Practice good personal hygiene and housekeeping procedures. For a variety of reasons, the lead concentration in workroom air may not correlate with the blood lead levels in individuals.
**Other Precautions:** Provide preplacement and periodic medical examinations which emphasize blood, nervous system, gastrointestinal tract, and kidneys, including a complete blood count and urinalysis. Receive a complete history including previous surgeries and hospitalization, allergies, smoking history, alcohol consumption, proprietary drug intake, and occupational and nonoccupational lead exposure. Maintain records for medical surveillance, airborne exposure monitoring, employee complaints, and physician's written opinions for at least 40 years or duration of employment plus 20 years. Measurement of blood lead level (PbB) and zinc protoporphyrin (ZPP) are useful indicators of your body's lead absorption level. Maintain worker PbBs at or below 40 µg/100 g of whole blood. To minimize adverse reproductive health effects to parents and developing fetus, maintain the PbBs of workers intending to have children below 30 µg/100 g. Elevated PbBs increase your risk of disease, and the longer you have elevated PbBs, the greater your chance of substantial permanent damage.

**Transportation Data (49 CFR 172.102)**
**IMO Shipping Name:** Lead compounds, soluble, n.o.s.
**IMO Hazard Class:** 6.1
**ID No.:** UN2291
**IMO Label:** St. Andrews Cross (X, Stow away from foodstuffs)
**IMDG Packaging Group:** III

*MSDS Collection* **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 142, 143
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

# Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
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GENIUM PUBLISHING CORP.

No. 26

MERCURY
(Revision C)
Issued: September 1981
Revised: August 1988

## SECTION 1. MATERIAL IDENTIFICATION 26

Material Name: MERCURY

**Description (Origin/Uses):** Used in barometers, thermometers, hydrometers, and pyrometers; in mercury arc lamps producing ultraviolet rays; in switches and fluorescent lamps; as a catalyst in oxidations of organic compounds; in alloys; in explosives; and for extracting gold and silver from ore.

**Other Designations:** Colloidal Mercury; Metallic Mercury; Quicksilver; Hg; Hydrargyrum;
CAS No. 7439-97-6

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

**Comments:** Inorganic and organic mercury compounds are highly toxic, as is pure mercury.

Genium

HMIS
H 3
F 0
R 0
PPG*
*See sect. 8

R 1
I 4
S 1
K 0

## SECTION 2. INGREDIENTS AND HAZARDS | % | EXPOSURE LIMITS

| | | |
|---|---|---|
| Mercury, CAS No. 7439-97-6 | Ca 100 | **OSHA PEL**<br>Ceiling: 1 mg per 10 $m^3$<br><br>**ACGIH TLV (Skin*), 1987-88**<br>TLV-TWA: 0.05 $mg/m^3$ as Hg (Mercury Vapor)<br><br>**Toxicity Data****<br>Rabbit, Inhalation, $LC_{Lo}$: 29 $mg/m^3$ (30 Hrs) |

*Mercury can be absorbed through intact skin, which contributes to overall exposure.
**See NIOSH, *RTECS* (OV4550000), for additional data with references to reproductive, mutagenic, and tumorigenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 673°F (357°C)
**Specific Gravity ($H_2O$ = 1):** 13.546 at 68°F (20°C)
**Vapor Pressure:** 0.0018 Torr at 77°F (25°C)
**Water Solubility (%):** Insoluble
**Molecular Weight:** 201 Grams/Mole
**Melting Point:** -37.93°F (-38.85°C)

**Appearance and Odor:** A silver, heavy liquid; odorless. **Danger:** Mercury vapor has no warning properties.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| * | * | % by Volume | * | * |

**Extinguishing Media:** *Mercury does not burn. Use extinguishing agents that will put out the surrounding fire.

**Unusual Fire or Explosion Hazards:** When exposed to the high temperatures that occur during a fire, mercury can vaporize to form extremely toxic fumes.

**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Mercury is stable in closed containers at room temperature under normal storage and handling conditions. It cannot undergo hazardous polymerization.

**Chemical Incompatibilities:** Hazardous reactions involving mercury and acetylene, ammonia, boron phosphodiiodide, chlorine, chlorine dioxide, methyl azide, sodium carbide, nitric acid, oleum, and sulfuric acid are reported (Genium ref. 84).

**Conditions to Avoid:** Do not expose mercury to incompatible chemicals.

**Hazardous Products of Decomposition:** Extremely toxic mercury metal fumes are likely to be produced during fires.

## SECTION 6. HEALTH HAZARD INFORMATION

Mercury is not listed as a carcinogen by the NTP, IARC, or OSHA.

**Summary of Risks:** Mercury is very toxic due to its liquid and fat solubility, lack of charge, and membrane permeability. It is a slowly cumulative poison that concentrates in the brain, kidneys, and liver. It is very hazardous when spilled or heated. Mercury and its vapor are rapidly absorbed by the membranes lining the respiratory tract, the gastrointestinal (GI) tract, and the skin. Mercury is a teratogen (causes physical defects in embryos). **Medical Conditions Aggravated by Long-Term Exposure:** Preexisting problems of the target organs can be worsened. Provide preplacement and periodic medical exams emphasizing the target organs. **Target Organs:** Skin, eyes, respiratory system, central nervous system (CNS), kidneys. **Primary Entry:** Skin absorption/contact, inhalation. **Acute Effects:** Erosion of the respiratory/GI tracts, nausea, vomiting, bloody diarrhea, shock, headache, metallic taste. Inhalation of high concentrations for short periods can cause pneumonitis, chest pain, dyspnea, coughing, stomatitis, gingivitis, and salivation. **Chronic Effects:** Tremors, emotional problems, loss of concentration, depression, drowsiness, fatigue, insomnia, loss of memory, kidney problems, eye lesions, vision disturbances, sore mouth and throat, problems with the sense of taste or smell, nosebleeds, nasal inflammation, loss of weight or appetite, poor hand-eye coordination, awkwardness, and unsteadiness, as well as dermatitis. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Immediately wash the affected area with soap and water because of the increased exposure from skin absorption. **Inhalation.** Remove exposed person to fresh air; restore and/or support his or her breathing as needed. Have medical personnel administer oxygen to treat the chemical pneumonitis that may develop. **Ingestion.** Never give anything by mouth to someone who is unconscious or convulsing. Note to physician: If indicated by degree of ingestion, saline cathartics and charcoal should be used. Chelation therapy with d-penicillamine may also be indicated.

**GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid. Treatment of chronic mercury poisoning requires expert medical care. At the first signs, immediately remove the exposed person from further exposure and have him or her examined and treated by a physician trained in occupational mercury poisoning.**

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, restrict access to the spill area to necessary personnel, and provide adequate ventilation. Clean up spills promptly. Specialized equipment and/or techniques may be required to safely deal with large mercury spills; if large quantities of mercury are used in the workplace, detailed, prior spill-management planning is recommended. Collect spilled mercury by using a suction pump and an aspirator bottle with a long capillary tube. For finely divided mercury in inaccessible cracks, corners, etc., treatment with calcium polysulfide and excess sulfur is recommended to convert the mercury globules into mercury sulfide. Vacuum cleaners may be used if they are equipped with specially designed mercury-absorbent exhaust filters. Collect the mercury into tightly sealed containers for later disposal or reclamation. Cleanup personnel must use the recommended personal protective equipment (see sect. 8).

**Waste Disposal:** Consider reclamation, recycling, or destruction rather than disposal in a landfill. Do not pour mercury down a drain. Mercury is very harmful to the environment. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**

Air Contaminant (29 CFR 19010.1000 Subpart Z)

**EPA Designations (40 CFR 302.4)**

RCRA Hazardous Waste No. U151

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg)*

*Per the Clean Water Act, § 407 (a); Clean Air Act, § 112; and Resource Conservation and Recovery Act, § 3001.

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing of mercury may occur, wear a full face shield or splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). **Other:** Wear impervious gloves, boots, aprons, gauntlets, etc., to prevent any contact with mercury and the skin.

**Ventilation:** Install and operate general and local ventilation systems powerful enough to continuously maintain airborne levels of mercury below the OSHA PEL standard cited in section 2.

**Safety Stations:** Make emergency eyewash stations, washing facilities, and safety/quick-drench showers available in work areas.

**Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean mercury from shoes and equipment. Separate work and street clothes; store work clothes in special lockers and always shower before changing to street clothes.

**Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off of your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store mercury in a cool, dry, well-ventilated area in tightly closed unbreakable polyethylene containers. Protect these containers from physical damage.

**Special Handling/Storage:** Construct storage areas to have smooth, hard, nonporous floors with no cracks or spaces so that spilled mercury globules do not form in inaccessible areas.

**Comments:** Mercury evaporates slowly, but if it is spilled it can form many tiny globules that evaporate much faster than a single pool of it will. In an unventilated area, significant concentration of mercury vapor can develop from this enhanced evaporation effect. This poisonous vapor is particularly hazardous if breathed over a long period of time, so spills or releases of mercury require very meticulous cleaning procedures.

**Transportation Data (49 CFR 172.101-2)**

**DOT Shipping Name:** Mercury, Metal
**DOT Hazard Class:** ORM-B
**DOT Label:** None
**DOT ID No.** NA2809
**IMO Class:** 8
**IMO Label:** Corrosive

**References:** 1, 2, 8, 26, 38, 84-94, 100.



Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

# Material Safety Data Sheet

From Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 624

NAPHTHALENE

Issued: November 1987

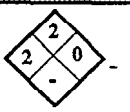
## SECTION 1. MATERIAL IDENTIFICATION

**Material Name:** NAPHTHALENE

**Description (Origin/Uses):** Used as a moth repellant and in many industrial processes.

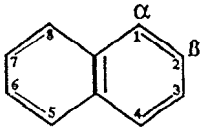
**Other Designations:** Naphthalin; Naphthene; Tar Camphor; $C_{10}H_8$; NIOSH *RTECS* No. QJ0525000; CAS No. 0091-20-3

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyer's Guide* (Genium ref. 73) for a list of suppliers.




| HMIS | | | |
|---|---|---|---|
| H | 2 | | |
| F | 2 | R | 1 |
| R | 0 | I | 4 |
| PPG* | | S | 1 |
| *See sect. 8 | | K | 2 |

## SECTION 2. INGREDIENTS AND HAZARDS

| Naphthalene, CAS No. 0091-20-3 | % | EXPOSURE LIMITS |
|---|---|---|
|  | ca 100 | IDLH* Level: 500 ppm<br><br>**ACGIH TLVs, 1987-88**<br>TLV-TWA: 10 ppm, 50 mg/m³<br>**OSHA PEL**<br>8-Hr TWA: 10 ppm, 50 mg/m³<br>**Toxicity Data****<br>Child, Oral, $LD_{Lo}$: 100 mg/kg<br>Man, Unknown, $LD_{Lo}$: 74 mg/kg<br>Rat, Oral, $LD_{50}$: 1250 mg/kg |



*Immediately dangerous to life and health
**See NIOSH *RTECS* for additional data with references to irritative, mutagenic, reproductive, and tumorigenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 424°F (218°C)
**Vapor Density (Air = 1):** 4.4
**Vapor Pressure:** 0.087 Torr at 77°F (25°C)
**Water Solubility:** Insoluble

**Specific Gravity ($H_20$ = 1):** 1.162 at 68°F (20°C)
**Melting Point:** 176°F (80°C)
**Molecular Weight:** 128 Grams/Mole
**% Volatile by Volume:** ca 100

**Appearance and Odor:** White crystalline flakes; strong coal tar odor.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| | | | | |
| 174°F (79°C) OC; 190°F (88°C) CC | 979°F (526°C) | % by Volume | 0.9 | 5.9 |

**Extinguishing Media:** Use water spray, dry chemical, or carbon dioxide to fight fires involving naphthalene. **Caution:** Foam or direct water spray applied to molten naphthalene may cause extensive foaming.

**Unusual Fire or Explosion Hazards:** Naphthalene is a volatile solid that gives off flammable vapor when heated (as in fire situations). This vapor is much denser than air and will collect in enclosed or low-lying areas like sumps. In these areas an explosive air-vapor mixture may form, and extra caution is required to prevent any ignition sources from starting an explosion or fire.

**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Naphthalene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.

**Chemical Incompatibilities:** Naphthalene is incompatible with strong oxidizing agents, chromic anhydride, and mixtures of aluminum trichloride and benzoyl chloride.

**Conditions to Avoid:** Ignition sources like open flame, unprotected heaters, excessive heat, lighted tobacco products, and electric sparks must not occur in work areas where naphthalene vapor may become concentrated.

**Hazardous Products of Decomposition:** Toxic gases like carbon monoxide are produced during fire conditions. Irritating, flammable vapor forms below the melting point because even solid naphthalene has a significant vapor pressure.

## SECTION 6. HEALTH HAZARD INFORMATION

Naphthalene is not listed as a carcinogen by the NTP, IARC, or OSHA.
**Summary of Risks:** Renal shutdown (kidney failure), hemolytic effects (breakdown of red blood cells), hematuria (blood in the urine), oliguria (low volume of urine), jaundice, eye damage, and depression of the central nervous system (CNS) are the primary health concerns associated with exposure to naphthalene. The ACGIH TLVs in section 2 are set to prevent eye damage. These recommended exposure limits may not be low enough to prevent blood changes in genetically hypersensitive individuals.
**Medical Conditions Aggravated by Long-Term Exposure:** Diseases of the blood, liver, and kidneys. Administer medical exams emphasizing these organs. **Target Organs:** Eyes, skin, kidneys, liver, blood (red blood cell effects), and CNS.
**Primary Entry:** Inhalation, skin contact. **Acute Effects:** Inhalation of naphthalene vapor causes excitement, confusion, headache, nausea, and loss of appetite. **Chronic Effects:** Increased incidence of cataracts.
**FIRST AID**
**Eye Contact:** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes to remove particles.
**Skin Contact:** Immediately wash the affected area with soap and water.
**Inhalation:** Remove victim to fresh air; restore and/or support his breathing as needed.
**Ingestion:** Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. Administer a gastric lavage followed by saline catharsis. Monitor blood and electrolytic balance. Other sources recommend giving the victim several glasses of water to drink.

**GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.**

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, provide ventilation, and eliminate all ignition sources immediately. Cleanup personnel need protection against contact and inhalation of vapor (see sect. 8). Contain large spills and collect waste. Use nonsparking tools to place naphthalene into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways.
**Waste Disposal:** Consider reclamation, recycling, or destruction rather than disposal in a landfill. Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**
Air Contaminant (29 CFR 1910.1000, Subpart Z)
**EPA Designations (40 CFR 302.4)**
RCRA Hazardous Waste, No. U165
CERCLA Hazardous Substance, Reportable Quantity: 100 lbs (45.4 kg)

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Follow the eye- and face-protection guidelines of 29 CFR 1910.133. **Respirator:** Use a NIOSH-approved respirator per the *NIOSH Pocket Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Respirator usage must be in accordance with the OSHA regulations of 29 CFR 1910.134. IDLH or unknown concentrations require an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres.
**Other Equipment:** Wear impervious gloves, boots, aprons, gauntlets, etc., as required by the specific work environment to prevent skin contact. **Ventilation:** Install and operate general and local maximum explosion-proof ventilation systems of sufficient power to maintain airborne levels of naphthalene below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove and launder contaminated clothing before wearing it again; clean this material from shoes and equipment.
**Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep this material off of your clothing and equipment. Avoid transferring this material from hands to mouth while eating, drinking, or smoking. Do *not* smoke, eat, or drink in any immediate work area. Avoid inhalation of vapor!

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage Segregation:** Store naphthalene in a cool, dry, well-ventilated area away from chemical incompatibles (see sect. 5).
**Special Handling/Storage:** Protect containers from physical damage. All bulk storage facilities must be built with an explosion-proof design. All containers used in shipping/transferring operations must be electrically grounded to prevent static sparks. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.
**Comments:** All operations with naphthalene must be done carefully to prevent accidental ignition of its flammable/explosive vapor. If the weather is warm, more naphthalene vapor forms and the potential for explosion increases. Do *not* smoke in any use or storage area!
**Transportation Data (49 CFR 172.101-2)**
**DOT Shipping Name:** Naphthalene
**DOT Hazard Class:** ORM-A
**IMO Class:** 4.1
**DOT ID No.** UN1334
**IMO Label:** Flammable Solid
**DOT Label:** None

References: 1, 2, 12, 73, 84-94, 103. PJI



Approvals
Indust. Hygiene/Safety
Medical Review

# Material Safety Data Sheet

from Genium's Reference Collection

Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 310
METHYLENE CHLORIDE
(Revision F)

Issued: September 1985
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION



**Material Name:** METHYLENE CHLORIDE

**Description (Origin/Uses):** Used widely in paint removers, as a solvent for plastics, as a degreasing agent, in propellant mixtures for aerosol sprays, and as a blowing agent in foams.

**Other Designations:** Dichloromethane; Freon 30®; Methane Dichloride; Methylene Bichloride; Methylene Dichloride; $CH_2Cl_2$; CAS No. 0075-09-2

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.


NFPA

HMIS
H 2
F 1
R 0
PPG*
*See sect. 8

R 1
I 3
S 3
K 1

## SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methylene Chloride, ca 100%

**OSHA PEL**
8-Hour TWA: 500 ppm
Ceiling: 1000 ppm Acceptable Maximum Peak above the Ceiling: 2000 ppm for 5 Minutes in Any 2-Hour Period

**ACGIH TLV, 1988-89**
TLV-TWA: 50 ppm, 175 mg/m³
(Adopted 1988-89)

**Toxicity Data***
Rat, Oral, $LD_{50}$: 2136 mg/kg
Human, Inhalation, $TC_{Lo}$: 500 ppm (8 Hours)

*See NIOSH, *RTECS* (PA8050000), for additional data with references to irritative, reproductive, mutagenic, and tumorigenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 103.55°F (39.75°C) at 76 Torrs
**Melting Point:** -142°F (-96.7°C)
**Vapor Density (Air = 1):** 2.9
**Vapor Pressure:** 440 Torrs at 77°F (25°C)
**Molecular Weight:** 84.94 Grams/Mole
**Solubility in Water (%):** 1% by Weight
**Specific Gravity ($H_2O$ = 1):** 1.3255 at 68°F (20°C)
**% Volatile by Volume:** Ca 100

**Appearance and Odor:** A clear, colorless, volatile liquid; distinctive, penetrating, ethereal odor. The odor will not serve as a useful warning property because concentrations of 100 ppm are not easily perceptible. Most persons can detect this odor at above 300 ppm.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point* | Autoignition Temperature: 1033°F (556°C) | LEL: 12% v/v | UEL: 19% v/v |
|---|---|---|---|

**Extinguishing Media:** *Methylene chloride is not flammable under ordinary conditions. However, flammable vapor-air mixtures can form at approximately 212°F (100°C). Use water spray to cool fire-exposed containers and to flush spills away from exposures. Use extinguishing agents that will put out the surrounding fire. **Unusual Fire or Explosion Hazards:** Methylene chloride vapor is heavier than air and may collect and concentrate in low-lying, confined spaces. The high vapor pressure of methylene chloride means that when it is spilled, its vapor concentration in air can increase rapidly. If this vapor is heated, an explosion hazard is associated with the vapor-air mixture. Containers of this material may rupture violently if they are involved in fires. **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

**Stability/Polymerization:** Methylene chloride is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methylene chloride can react dangerously with nitrogen tetroxide, liquid oxygen, potassium, sodium, sodium-potassium alloys, lithium, potassium hydroxide with N-methyl-N-nitroso urea, potassium *t*-butoxide, and finely powdered aluminum and magnesium. **Conditions to Avoid:** Avoid all exposure to sources of ignition, heat, and incompatible chemicals. Prolonged exposure to water may cause hydrolysis to highly corrosive hydrochloric acid when the temperature is above 140°F (60°C). In oxygen-enriched atmospheres or when heated (>212°F [100°C]), methylene chloride vapor can be readily ignited. **Hazardous Products of Decomposition:** Exposure to high temperature (from open flame, hot surfaces, uninsulated steam lines, welding arcs, etc.) can produce toxic and corrosive thermal-oxidative products of decomposition such as hydrogen chloride, carbon monoxide, and even small quantities of phosgene gas, which is extremely poisonous.

## SECTION 6. HEALTH HAZARD INFORMATION

**Carcinogenicity:** Methylene chloride is listed as a suspected human carcinogen by the ACGIH (which classifies it as a group A2 carcinogen). **Summary of Risks:** Accidental contact of liquid methylene chloride with skin or eyes causes painful irritation and possible burns if not promptly removed. Exposure by way of contaminated gloves, clothing, or paint remover formulations can produce these same irritant effects. Long-term exposure to mild or moderate doses of methylene chloride may cause a delayed (24 to 48 hours) onset of dizziness, headache, mental confusion, slurred speech, double vision, and sleeplessness. Medical recovery can be slow. Overexposure to methylene chloride can cause elevated levels of carboxy hemoglobin in the blood (this same effect results from overexposure to carbon monoxide). **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, respiratory system, CNS, liver, kidneys, and blood. **Primary Entry:** Inhalation, skin contact/absorption. **Acute Effects:** Headache, giddiness, stupor, irritability, fatigue, tingling in the limbs, and narcosis that is not usually fatal if the exposure is terminated before anesthetic death occurs. **Chronic Effects:** The ACGIH classification of this material as a suspected human carcinogen implies that cancer is a possible effect of chronic exposure to methylene chloride. **FIRST AID:** Eyes. Immediately flush eyes, including under the eyelids, gently but thoroughly with

## SECTION 6. HEALTH HAZARD INFORMATION, cont.

flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water and then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Note to Attending Physician:** Do not administer adrenalin. **Ingestion.** Unlikely. Should this type of exposure occur, do not induce vomiting because of the danger of aspiration. If spontaneous vomiting should occur, position the exposed person's head below his or her trunk to resist aspiration. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** Absorbed methylene chloride is stored in body fat and metabolizes to carbon monoxide. This produced carbon monoxide increases and sustains carboxyhemoglobin levels in the blood, which concommitantly reduces the oxygen-carrying capacity of the blood. NIOSH advises preplacement and annual medical exams that emphasize liver, kidney, eye, skin, CNS, and respiratory system functions and a complete blood count. Simultaneous exposure to tobacco smoke, alcohol, and carbon monoxide, along with heavy manual labor, increases the body burden of a worker as well as the toxic hazards of the methylene chloride. In significant exposures, serum methylene chloride levels are of no clinical importance. Neurologic and hepatic status as well as carboxy hemoglobin should be monitored.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against this liquid's contact with the skin or eyes as well as inhalation of its vapor. Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
**EPA Designations (40 CFR 302.4)**
RCRA Hazardous Waste, NO. U080
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Clean Water Act (CWA), § 307 (a), and the Resource Conservation and Recovery Act (RCRA), § 3001.

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious neoprene, PVA, or Viton gloves, boots, aprons, and gauntlets, etc., to prevent any skin contact with liquid methylene chloride. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of acetone below the exposure limits cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. Floor or sump ventilation may be necessary. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment. **Other:** Because the health effects of carbon monoxide and methylene chloride are additive (see sect. 6), workplaces should be equipped with automatic sensing equipment that identifies workroom atmospheric levels of both of these materials. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material and before eating, drinking, smoking, using the toilet, or applying cosmetics. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methylene chloride vapor.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store methylene chloride in closed, moisture-proof containers in a cool, dry, well-ventilated area away from sources of ignition, strong oxidizers, caustics, and incompatible chemicals (see sect. 5). Protect containers from physical damage. **Special Handling/Storage:** Prevent moist air from entering storage containers. Provide ventilation at the floor level in storage areas because methylene chloride vapor is denser than air. Installation of a dryer and a safety seal on each tank is recommended. Aluminum is not recommended for use as a storage material; appropriate storage materials include galvanized iron, black iron, or steel. **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum explosion-proof design. Electrically ground and bond all containers and pipelines used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks.

**Transportation Data (49 CFR 172.101-2)**
**DOT Shipping Name:** Dichloromethane *or* Methylene Chloride
**DOT Hazard Class:** ORM-A
**ID No.** UN1593
**DOT Packaging Requirements:** 49 CFR 173.605
**DOT Packaging Exceptions:** 49 CFR 173.505

**IMO Shipping Name:** Dichloromethane
**IMO Hazard Class:** 6.1
**IMO Label:** Saint Andrew's Cross (X)*
**IMDG Packaging Group:** III

*Harmful-Stow away from Foodstuffs.

References: 1, 26, 38, 84-94, 100, 116, 117, 120, 122.



Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

## Section 6. Health Hazard Data

**Carcinogenicity:** The IARC and NTP classify nickel as, respectively, a human carcinogen (Group 1) and an anticipated human carcinogen.
**Summary of Risks:** Nickel dust or fume is a respiratory irritant that with chronic exposure may cause nasal or lung cancer in humans. The average latency period for the induction of these cancers appears to be about 25 yr (within a 4- to 51-yr range). Experimental studies show nickel also has neoplastigenic, tumorigenic, and teratogenic effects in laboratory animals. Hypersensitivity to nickel is common and can cause conjunctivitis, allergic contact dermatitis, and asthma. The allergic contact dermatitis ("nickel-itch," a pink papular erythema with pustulation and ulceration) usually clears within one week, but sensitization is permanent.
**Medical Conditions Aggravated by Long-Term Exposure:** Chronic pulmonary, upper respiratory tract, and skin disorders. Carcinoma of the paranasal sinuses, larynx, and lung may also develop.
**Target Organs:** Nasal cavities, lungs, skin.
**Primary Entry Routes:** Inhalation, dermal contact, and ingestion.
**Acute Effects:** Exposure to nickel fumes can cause upper respiratory tract irritation (with nonproductive cough, rapid breathing, dyspnea, chest tightness), metal fume fever (chills, fever, flu-like symptoms), asthma, inflammation of the lungs (noninfectious pneumonia), eye (conjunctiva) irritation, nausea, vomiting, and abdominal pain. Dermal contact causes "nickel itch." Ingesting large doses causes nausea, vomiting, and diarrhea.
**Chronic Effects:** Prolonged or repeated contact can cause nickel sensitization. Symptoms of sensitization include nickel dermatitis with eczematous skin and lichenification (hardened and leathery skin). Chronic inhalation exposure can cause chronic pulmonary irritation, chronic thickening of the mucous membranes of the nose, nasal sinusitis, anosmia (loss or impairment of the sense of smell), and perforation of the nasal septum. Chronic exposure to dust and fumes may cause carcinoma of paranasal sinuses, larynx, and lung.
FIRST AID
**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
**Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
**Inhalation:** Remove exposed person to fresh air and support breathing as needed.
**Ingestion:** Since oral toxicity for elemental nickel is low, inducing vomiting is seldom necessary. In cases of severe vomiting or diarrhea, treat for fluid replacement.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Physician's Note:** Chronic exposure to nickel dust may cause *eosinophilic pneumonitis* (Loeffler's syndrome) which responds well to systemic cortico-steroids. There are cases of host rejection of nickel-containing prostheses after development of nickel sensitivity.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personal should protect against vapor inhalation and dermal contact. Avoid dust generation. Using nonsparking tools, carefully scoop spilled material into appropriate containers for reclamation or disposal. After completing material pickup, wash spill site. Do not release to sewers or waterways. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
EPA Designations
RCRA Hazardous Waste (40 CFR 261.33): Not listed
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 1 lb (0.454 kg) [* per Clean Water Act, Sec. 307(a)]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
OSHA Designations
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact.
**Ventilation:** Provide general and local explosion-proof ventilation systems to maintain airborne concentrations below the OSHA PEL, ACGIH TLV, and NIOSH REL (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in tightly closed containers in a cool, dry, well-ventilated area away from incompatible materials (Sec. 2). Protect against physical damage. Store Raney nickel under inert gas or water in tightly closed containers away from heat or ignition sources, acids, caustics, and oxidizing materials.

**Engineering Controls:** Minimize all possible exposures to potential carcinogens. Avoid vapor inhalation and dermal contact. Use only with appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.

**Other Precautions:** Provide preplacement and periodic medical examinations that emphasize the skin, nasal cavities, and lungs, including a 14" x 17" chest roentgenogram and urine nickel determinations.

**Transportation Data (49 CFR 172.102)**
**IMO Shipping Name:** Nickel catalyst, wetted with not less than 40% water or other suitable liquid, by weight, finely divided, activated, or spent
**IMO Hazard Class:** 4.2
**ID No.:** UN 1378
**IMO Label:** Spontaneously combustible
**IMDG Packaging Group:** II

*MSDS Collection* **References:** 26, 38, 73, 84, 85, 88, 89, 90, 100, 101, 103, 109, 124, 126, 132, 133, 134, 136, 138, 139, 140, 142, 143
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Hardies, MD; **Edited by:** JR Stuart, MS

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Sheet No. 723
Nickel Metal

Issued: 8/90

## Section 1. Material Identification



**Nickel (Ni) Description:** Found in ores in combination with sulphur, oxygen, antimony, arsenic, and/or silica. The Orford (sodium sulfide and electrolysis) and the Mond (nickel carbonyl) processes are used to refine nickel. Used in electroplating, casting operations for machine parts, manufacturing acid-resisting and magnetic alloys and tapes, synthesizing acrylic esters; in surgical and dental prostheses, coinage, catalytic gastrification of coal, paint pigments, Ni-Cd batteries, ceramics and glass; and as a catalyst in hydrogenation of fats and oils.

**Other Designations:** CAS No. 7440-02-0, Raney alloy, Raney nickel.*

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.

**Cautions:** Nickel is an eye, skin, and respiratory tract irritant. *Chronic inhalation of nickel dust or fumes may cause cancer of the lungs and nasal passages. Nickel powder (Raney nickel) is a dangerous fire hazard.*

| | |
|---|---|
| R | 0 |
| I | 3 |
| S | 2 |
| K | 1 |

NFPA


catalyst

| HMIS | |
|---|---|
| H | 2 |
| F | 4 |
| R | 0 |
| PPG† | |

Genium


metal

| HMIS | |
|---|---|
| H | 2 |
| F | 1 |
| R | 0 |
| PPG† | |

† Sec. 8

* Raney nickel is prepared by leaching (with 25% caustic soda solution) aluminum from an alloy of 50% aluminum and 50% nickel. It is used as a catalyst for hydrogenation. Raney nickel, a silvery gray metal powder, is a dangerous fire risk and ignites spontaneously in air (Sec. 4). Nickel catalysts cause many industrial accidents.

## Section 2. Ingredients and Occupational Exposure Limits

Nickel, ca 100%

| 1989 OSHA PEL | 1989-90 ACGIH TLV | 1988 NIOSH REL | 1985-86 Toxicity Data* |
|---|---|---|---|
| 8-hr TWA: 1 mg/m³ | TLV-TWA: 1 mg/m³ | 0.015 mg/m³ | Dog, intravenous, $LD_{Lo}$: 10 mg/kg<br>Guinea pig, oral, $LD_{Lo}$: 5 mg/kg<br>Rat, implant, $TD_{Lo}$: 250 mg/kg |

* See NIOSH, *RTECS* (QR5950000), for additional mutative, reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 4946 °F (2730 °C)
**Melting Point:** 2651 °F (1455 °C)
**Vapor Pressure:** 1 mm at 3290 °F (1810 °C)
**Atomic Weight:** 58.71
**Density:** 8.90 at 25 °C
**Water Solubility:** Insoluble

**Appearance and Odor:** A silvery-white, hard, malleable and ductile metal.

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Smother with suitable dry powder or use large amounts of water.

**Unusual Fire or Explosion Hazards:** Nickel is combustible as dust or powder. Raney nickel ignites spontaneously in air. Nickel carbonyl (*MSDS Collection*, No. 226), a highly toxic substance, may form under fire conditions.

**Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since nickel dust or powder is toxic if inhaled, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Nickel is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** Nickel can react violently with fluorine, ammonium nitrate, hydrogen + dioxane, performic acid, selenium, sulfur, ammonia, hydrazine, phosphorus, and titanium + potassium chlorate. Nickel is also incompatible with oxidants. Raney nickel catalysts may initiate hazardous reactions with sulfur compounds, *p*-dioxane, hydrogen, hydrogen + oxygen, ethylene + aluminum chloride, magnesium silicate, methanol, and organic solvents + heat.

**Conditions to Avoid:** Avoid incompatibilities.

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of nickel can produce highly toxic nickel carbonyl.

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*Material Safety Data Sheets Collection:*

Sheet No. 517
**Pentachlorophenol**

Issued: 10/83 Revision: A, 11/90

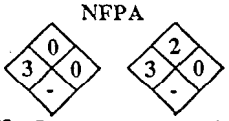
## Section 1. Material Identification



**Pentachlorophenol ($C_6HCl_5O$) Description:** Derived by chlorination of phenol in the presence of a catalyst. Used as a fungicide, a bactericide, a molluscicide, an algicide, an insecticide (termite control) and herbicide (pre-harvest defoliant); in sodium pentachlorophenate; in wood preservation (telephone poles, pilings, etc.), wood products, starches, dextrins, and glues. Other registered industrial uses include boat and building construction; treatment of cable coverings, canvas belting, nets, and construction lumber and poles; mold control in petroleum drilling and production; incorporation in paints, pulp, pulp stock, paper, cooling tower water, and hardboard and particle board. Registered homeowner uses include maintenance of boats, trailers, station wagons, siding, fences, and outdoor furniture.
**Other Designations:** CAS No. 0087-86-5, chlorophen, PCP, penchlorol, penta.
**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*(73) for a suppliers list.
**Cautions:** Pentachlorophenol is *highly toxic by skin absorption, ingestion, and inhalation.* The agent is highly irritating. General metabolism, the heart, the circulatory system, the liver, and the kidneys may be affected.

R 1
I 3
S 2*
K 0
* Skin absorption

NFPA




Dry

| HMIS |
|---|
| H 3 |
| F 0 |
| R 0 |
| PPG‡ |
| ‡ Sec. 8 |

Solution†

| HMIS |
|---|
| H 3 |
| F 2 |
| R 0 |
| PPG‡ |
| ‡ Sec. 8 |

† PCP is freely soluble in alcohol, ether, and benzene. Depending on medium, PCP's health and flammability hazards increase in solution with such media.

## Section 2. Ingredients and Occupational Exposure Limits

Pentachlorophenol, ca 100%*

**1989 OSHA PEL**
8-hr TWA (skin): 0.5 mg/m³

**1990-91 ACGIH TLV**
TWA (skin): 0.5 mg/m³

**1985-86 Toxicity Data†**
Rat, oral, $LD_{50}$: 27 mg/kg ingested affects the vascular (blood pressure elevation), endocrine (hyperglycemia), nutritional, and gross metabolic (body temperature increase) systems
Rat, inhalation, $LC_{50}$: 355 mg/m³ inhaled affects behavior (excitement; muscle contraction or spasticity) and respiration (shortness of breath)

**1987 IDLH Level**
150 mg/m³

**1988 NIOSH REL**
None established

* Technical grade pentachlorophenol contains traces of hexa, hepta, and octachlorodibenzo-p-dioxins; hexa, hepta, and octachlorodibenzofurans; and hexachlorobenzene.
† See NIOSH, *RTECS* (SM6300000), for additional irritative, mutative, reproductive, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 588 to 590 °F (309 to 310 °C),* 592 °F (311 °C) (decomposes)†
**Melting Point:** 374 °F (190 °C),* 374 °F (190 °C)†
**Vapor Pressure:** 0.00011 mm Hg at 77 °F (25 °C)
**Vapor Density (Air = 1):** 9.2
**Molecular Weight:** 266.35
**Specific Gravity (22 °C/4 °C):** 1.978
**Water Solubility:** 14 mg/l at 20 °C

**Appearance and Odor:** Light brown or tan flake or solid with a phenolic odor and pungent taste. Odor detection is at 1.6 mg/l.

* Pentachlorophenol solution
† Dry pentachlorophenol

## Section 4. Fire and Explosion Data

| Flash Point: None reported | Autoignition Temperature: None reported | LEL: None reported | UEL: None reported |
|---|---|---|---|

**Extinguishing Media:** Since pentachlorophenol is noncombustible, use extinguishing media appropriate to the surrounding fire: dry chemical, water spray, carbon dioxide, or foam. Use the water spray to cool fire-exposed containers.
**Unusual Fire or Explosion Hazards:** When involved in a fire, pentachlorophenol emits toxic fumes. Wood treated with 5% pentachlorophenol solution or pentachlorophenol in petroleum solvents such as mineral spirits or kerosine are combustible.
**Special Fire-fighting Procedures:** Isolate hazard area and deny entry. Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective equipment. Avoid skin contact. If feasible, remove containers from fire area. Be aware of runoff from fire control methods. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Pentachlorophenol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Pentachlorophenol solutions subjected to sunlight or ultraviolet light undergo photochemical degradation.
**Chemical Incompatibilities:** Pentachlorophenol is incompatible with strong oxidizers and alkalies.
**Conditions to Avoid:** Avoid contact with heat and ignition sources (open flame, electric arcs, or hot surfaces) which can cause thermal decomposition.
**Hazardous Products of Decomposition:** Thermal oxidative decomposition of pentachlorophenol can produce hydrogen chloride, chlorine, and chlorinated hydrocarbons. Prolonged heating above 392 °F (200 °C) produces traces of octachlorodibenzo-para-dioxin.

## Section 6. Health Hazard Data

**Carcinogenicity:** There is animal evidence of an increase in liver and endocrine tumors in some research studies, but not in others. Also, PCP shares some structural similarity to other carcinogens. However, NTP, IARC, and OSHA do not list PCP as a carcinogen. It may be toxic to the fetus, especially during early pregnancy.
**Summary of Risks:** Airborne exposure is irritating to the eyes, skin, throat, and lungs, and may cause acute and possibly chronic effects (see below). Levels above 1 mg/m³ may cause cough, sneezing, and tearing of the eyes, especially in unacclimated workers. Skin contact is also irritating and provides an efficient way for the chemical to enter the body and cause systemic poisoning. Skin rashes (dermatitis) including chloracne (a severe and persistent cystic form of acne characterized by blackheads, whiteheads, and yellow cysts) may result from repeated or prolonged contact with even dilute solutions (e.g., 1%). Ingestion may cause severe systemic poisoning.

*Continue on next page*

## Section 6. Health Hazard Data, *continued*

**Medical Conditions Aggravated by Long-Term Exposure:** Individuals with kidney, liver, endocrine, and metabolic disorders may be at a higher risk from exposure to pentachlorophenol. Consult a physician.
**Target Organs:** Cardiovascular system, endocrine system, general metabolism, liver, kidneys, respiratory system, eyes, skin, and central nervous system (CNS).
**Primary Entry Routes:** Inhalation, skin absorption, ingestion, eye contact.
**Acute Effects:** Acute exposures are irritating and may cause tachycardia (rapid heartbeat), tachypnea (rapid breathing), hypertension (high blood pressure), fevers, muscular weakness, anorexia (loss of appetite), sweating, dizziness, and nausea. Very high doses may cause unconsciousness, seizures (convulsions), or death due to cardiac arrest. The risk of acute poisoning may increase in hot weather.
**Chronic Effects:** Absorption of PCP and/or its contaminants may cause chloracne. Bronchitis and weight loss may develop. Animal studies suggest that liver and kidney damage may occur.
**FIRST AID**
**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water until transported to an emergency medical facility. Consult a physician immediately.
**Skin:** *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. For reddened or blistered skin, consult a physician. Wash affected area with soap and water.
**Inhalation:** Remove exposed person to fresh air and support breathing with artificial respiration, CPR if necessary, and oxygen if available.
**Ingestion:** Call a physician or Poison Control Center immediately. Never give anything by mouth to an unconscious or convulsing person. If ingested, have that *conscious* person drink 1 to 2 glasses of water, then induce vomiting. If possible, induce vomiting under medical supervision. Do not instill milk or other materials containing vegetable or animal fats since they are likely to enhance absorption.
**After first aid, get appropriate in-plant, paramedic, or community medical support.**
**Note to Physicians:** Severe systemic poisoning results primarily from uncoupling of mitochondrial oxidative phosphorylation, with ensuing hyperpyrexia. Promote heat loss and aggressively manage hyperthermia with physical methods. *Antipyretics (including aspirin), atropine, and phenothiazines are contraindicated.* Force diuresis to reduce body burden. Carefully follow and treat fluid/electrolyte and acid/base alterations. Treat supportively and reduce anxiety. Diagnostic testing should include rectal temperature, PCP urine or plasma levels, blood chemistries (including electrolytes, LFTs, BUN, creatinine), and CBC. Treat ingestion with emesis, gastric lavage, and saline cathartic.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel, evacuate all unnecessary personnel, provide adequate ventilation, and remove all heat and ignition sources. Cleanup personnel need full protection against vapor inhalation and contact with solution or solid. Collect dry spilled material in a metal container for reclamation or disposal. For liquid spills, collect with an absorbent solid and place in a metal container for disposal. For large liquid spills, dike far ahead of liquid spill to contain. Wash residue with soap and water. Prevent spills from entering sewers, streams, and open waters. Pentachlorophenol is toxic to fish and wildlife. Follow applicable OSHA regulations (29 CFR 1910.120).
**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.
**EPA Designations**
Listed as a RCRA Hazardous Waste (40 CFR 261.33), RCRA Waste No. U242
Listed as a CERCLA Hazardous Substance* (40 CFR 302.4), Reportable Quantity (RQ): 10 lb (4.54 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]
SARA Extremely Hazardous Substance (40 CFR 355): Not listed
Listed as a SARA Toxic Chemical (40 CFR 372.65)
**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).
**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, where concentrations of pentachlorophenol exceed or are likely to exceed .5 mg/m³, wear a NIOSH-approved organic vapor-dust filter type respirator; a full facepiece is needed at concentrations >2.5 mg/m³. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA; SCBA can be used to 150 mg/m³. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*
**Other:** Wear impervious gloves (polyvinyl chloride, neoprene or nitrile latex), boots, aprons, and gauntlets to prevent skin contact. Extremely high concentrations may require a full containment suit. Always consult an industrial hygienist.
**Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below both OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]
**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.
**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing. Use separate lockers for street clothes.
**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in properly labeled and closed containers in a cool, dry, well-ventilated, low fire hazard area away from heat and ignition sources and combustible materials. Protect containers from physical damage. Outside or detached storage is preferred. Accumulated sludge at the bottom of dipping tanks may concentrate toxic impurities at much higher levels than original product. Do not reuse drums. Clean empty drums, liners, and block wrappings in accordance with 40 CFR 261.7(b)(3) prior to returning for reconditioning, recycling, or other disposal.
**Engineering Controls:** Educate workers about pentachlorophenol's hazards. Avoid skin contact and vapor or dust inhalation. Use only with adequate ventilation and appropriate personal protective gear. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Practice good personal hygiene and housekeeping procedures.
**Medical Surveillance:** Preplacement and periodic medical evaluations should include a complete history and physical examination and a biochemical profile (including LFTs, BUN, creatinine, and electrolytes). Consider baseline pulmonary function tests. Perform biologic monitoring for PCP levels at the end of work shifts (plasma) and toward end of workweek (urine). 24-hr urine collections are more accurate than spot testing.

**Transportation Data (49 CFR 172.102)**

| | |
|---|---|
| **IMO Shipping Name:** Chlorophenols, liquid | **IMO Shipping Name:** Chlorophenols, solid |
| **IMO Hazard Class:** 6.1 | **IMO Hazard Class:** 6.1 |
| **ID No.:** UN2021 | **ID No.:** UN2020 |
| **IMO Label:** St. Andrews Cross | **IMO Label:** St. Andrews Cross |
| **IMDG Packaging Group:** III | **IMDG Packaging Group:** III |

*MSDS Collection* References: 1, 38, 73, 84, 85, 88, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138, 140, 143, 146
**Prepared by:** MJ Allison, BS; **Industrial Hygiene Review:** DJ Wilson, CIH; **Medical Review:** MJ Upfal, MD, MPH; **Edited by:** JR Stuart, MS

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*Material Safety Data Sheets Collection:*

Sheet No. 355
**Phenol**

Issued: 9/80 Revision: C, 11/90

## Section 1. Material Identification 33

**Phenol ($C_6H_5OH$) Description:** One of many aromatic compounds in coal tar. Made by alkylating benzene with propylene then oxidizing the resulting cumene to produce phenol and acetone. Used as a feedstock in manufacturing various phenolic resins, caprolactum, bis-phenol-A, and other chemicals and drugs; a disinfectant; a fuel-oil sludge inhibitor; a reagent in chemical analysis; in producing or manufacturing a large variety of aromatic compounds including fertilizers, illuminating gas, coke, explosives, lampblack, paints, paint removers, asbestos goods, wood preservatives, textiles, perfumes, bakelite, rubber, and other plastics; in medical and industrial organic compounds and dyes; and in germicidal paints and slimicides. Phenol has been identified in cigarette smoke and automobile exhaust.

**Other Designations:** CAS No. 0108-95-2, carbolic acid, hydroxybenzene, monohydroxy benzene, oxybenzene, phenic acid, phenyl alcohol, phenyl hydroxide.

**Manufacturer:** Contact your supplier or distributor. Consult the latest *Chemicalweek Buyers' Guide*[73] for a suppliers list.

**Cautions:** Phenol has a marked corrosive effect on any tissue. Eye contact may cause severe damage and *blindness*. Its primary entry route is through *skin absorption*. Systemic absorption may cause *liver and kidney damage, convulsions (seizures), or death.*

R 1
I 4
S 3*
K 2
* Skin absorption

NFPA
2
3 0
-

HMIS
H 3
F 2
R 0
PPG†
† Sec. 8

## Section 2. Ingredients and Occupational Exposure Limits

Phenol, ca 100%

**1989 OSHA PEL (Skin)**
8-hr TWA: 5 ppm, 19 mg/m³

**1990-91 ACGIH TLV (Skin)**
TWA: 5 ppm, 19 mg/m³

**1988 NIOSH REL**
TWA: 5 ppm, 19 mg/m³
Ceiling: 15.6 ppm, 60 mg/m³

**1985-86 Toxicity Data***
Mammal, inhalation, $LC_{50}$: 74 mg/m³
Rat, oral, $LD_{50}$: 317 mg/kg; toxic effects include behavorial changes (convulsions or effect on seizure threshold)
Rabbit, eye, $TC_{Lo}$: 5 mg produces severe irritation

**1987 IDLH Level**
250 ppm

* See NIOSH, *RTECS* (SJ3325000), for additional irritative, mutative, reproductive, tumorigenic, and toxicity data.

## Section 3. Physical Data

**Boiling Point:** 359.15 °F (181.75 °C) at 760 mm Hg
**Melting Point:** 109.4 °F (43 °C)
**Vapor Pressure:** 0.3513 mm Hg at 77 °F (25 °C)
**Vapor Density (Air = 1):** 3.24
**pH:** 6 (aqueous solution)
**Molecular Weight:** 94.11
**Specific Gravity (20 °C/4 °C):** 1.0576
**Water Solubility:** 1 g dissolves in about 15 ml $H_2O$
**Viscosity:** 12.7 centipoise at 64.9 °F (18.3 °C)

**Appearance and Odor:** White crystalline solid with a characteristic sharp medicinal sweet, tangy odor detectable above 0.05 ppm. Phenol turns pink or red if it contains impurities or is exposed to heat or light.

## Section 4. Fire and Explosion Data

| Flash Point: 175 °F (79 °C), CC | Autoignition Temperature: 1319 °F (715 °C) | LEL: 1.7% v/v | UEL: 8.6% v/v |
|---|---|---|---|

**Extinguishing Media:** Use water spray, carbon dioxide, dry chemical, or alcohol-type foam to extinguish fires involving phenol. Do not use a solid stream of water since the stream scatters and spreads fire. Use water spray to cool fire-exposed tanks/containers.

**Unusual Fire or Explosion Hazards:** Phenol presents a moderate fire hazard when exposed to heat, flame, or oxidizers. When heated, it emits toxic fumes and vapors that form explosive mixtures with air. Air mixtures containing 3 to 10% phenol are explosive. Solid phenol burns with difficulty, giving off heavy smoke.

**Special Fire-fighting Procedures:** Since fire may produce toxic fumes, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode and full protective clothing. Be aware of runoff from fire control methods. Water containing phenol can cause severe chemical burns. Do not release to sewers or waterways.

## Section 5. Reactivity Data

**Stability/Polymerization:** Phenol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur.

**Chemical Incompatibilities:** In general, phenol is incompatible with strong oxidizing agents and halogens. It coagulates colodion and proteins. A potentially explosive reaction occurs with formaldehyde, peroxydisulfuric acid, peroxymonosulfuric acid, sodium nitrite + heat, and aluminum chloride + nitromethane (at 110 °C/100 bar). A violent reaction occurs with butadiene, sodium nitrite + trifluoroacetic acid, and aluminum chloride + nitrobenzene at 248 °F (120 °C). Combining phenol with mineral oxidizing acids results in fire; with acetaldehyde results in violent condensation; with isocyanates results in heat generation and violent polymerization, with calcium hypochlorite results in an exothermic reaction producing toxic fumes which may ignite; and with nitrides results in heat and flammable gas generation. Hot phenol is corrosive to many metals, including aluminum, lead, magnesium, and zinc. Reaction with these materials causes phenol to discolor.

**Conditions to Avoid:** Avoid heating phenol above 122 °F (90 °C).

**Hazardous Products of Decomposition:** Thermal oxidative decomposition of phenol can produce oxides of carbon and water.

## Section 6. Health Hazard Data

**Carcinogenicity:** The NTP, IARC, and OSHA do not list phenol as a carcinogen. Although no specific evidence of human cancer exists, its carcinogenicity to mice emphasizes the need for precaution when handling this material. Phenol also causes human mutations (genetic changes).

**Summary of Risks:** Phenol is a general protoplasmic poison that is corrosive to any living tissue it contacts. Toxicity most likely results from dermal (skin) contact or ingestion. Skin absorption occurs readily with a rapid onset of symptoms or death (within 30 min to several hours). Contact with eyes may cause severe damage and blindness. Ingestion of 1 g may be fatal. Although phenol is irritating to the respiratory tract, due to its low volatility and good warning properties, inhalation is typically less of a concern. Chronic toxic effects are uncommon, but may include digestive disturbances, neurological disorders, skin rash (dermatitis), and liver and kidney damage.

**Medical Conditions Aggravated by Long-Term Exposure:** Individuals with chronic respiratory disorders, pre-existing skin disorders, convulsive disorders, or kidney or liver abnormalities may be at increased risk from phenol exposure.

**Target Organs:** Liver, kidneys, nervous system, and skin.

**Primary Entry Routes:** Skin absorption, eye contact, ingestion, and inhalation.

**Acute Effects:** Skin contact results in white, wrinkled discoloration, followed by a severe burn or systemic poisoning if removed improperly.

*Continue on next page*

## Section 6. Health Hazard Data, *continued*

Phenol ingestion can cause gangrene and corrosion of lips, mouth, throat, esophagus, and stomach if not properly decontaminated (see First Aid). Although not immediately painful, skin contact can cause serious burns and systemic toxicity. In addition to skin burns and respiratory tract irritation, systemic absorption may cause pallor, anorexia (appetite loss), nausea, vomiting, diarrhea, weakness, muscle aches, darkened urine, headache, tinnitus (ringing in ears), sweating, convulsions, cyanosis (bluish coloration of lips and/or fingertips), shock, unconsciousness, respiratory failure, and death. After ingestion, major percutaneous (skin), or inhalation exposures, collapse and death can be rapid. Ingestion can cause severe tissue corrosion or gangrene affecting lips, mouth, throat, esophagus, and stomach. Eye contact can cause severe corrosive damage to the eye (conjunctival edema, corneal opacification, and hypesthesia) and possible blindness.

**Chronic Effects:** Chronic phenol poisoning is rarely reported. Symptoms include vomiting, difficulty swallowing, diarrhea, appetite loss, headache, fainting, dizziness, darkened urine, and mental disturbances. Chronic exposure can cause death from liver and kidney damage. Repeated skin contact with phenol or phenol-bearing products can result in dermatitis with dark pigmentation (ochronosis) of skin and whites of eyes (sclerae).

**FIRST AID**

**Eyes:** Gently lift the eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician immediately.

**Skin:** Speedy action is critical. Flood exposed area with water and quickly remove contaminated clothing. *As soon as possible*, repeatedly spray or swab with the decontaminating agent polyethyleneglycol-300 (PEG). Immerse extremities in PEG. Rescue personnel should protect themselves from skin contact with phenol. Do not use greases, powders, or ointments to treat phenol burns. *Never* delay phenol removal if PEG is not readily available. Use soap and water instead.

**Inhalation:** Remove exposed person to fresh air and support breathing as needed.

**Ingestion:** *Speed is essential in the treatment of oral poisoning.* Immediately consult a physician and poison center. Never give anything by mouth to an unconscious or convulsing person. Administer to that *conscious* person 15 to 30 cc castor oil or another vegetable oil, and be prepared to induce vomiting upon a physician's advice. Vegetable oils slow phenol absorption and reduce local damage.

**After first aid, get appropriate in-plant, paramedic, or community medical support.**

**Note to Physicians:** Treat ingestion with gastric lavage using 40% aqueous Bacto-Peptone, milk, or water until phenolic odor is eliminated. Then give 15 to 50 cc castor or vegetable oil. Debride necrotic skin. Monitor vital signs, fluid status, electrolytes, BUN, renal and hepatic function, and electrocardiogram. Manage sedation, seizures, renal failure, and fluid electrolyte imbalances symptomatically as indicated.

## Section 7. Spill, Leak, and Disposal Procedures

**Spill/Leak:** Notify safety personnel, evacuate all unnecessary personnel, remove all heat and ignition sources, and provide maximum explosion-proof ventilation. Cleanup personnel should protect against vapor inhalation and skin and eye contact with a self-contained breathing apparatus and full personal protective clothing and equipment. Absorb small spills with some noncombustible inert material and place in a closed metal container for disposal. Dike large spills and allow material to cool and solidify. Using nonsparking tools, shovel solid into steel containers for disposal. Thoroughly flush spill area with water, use caustic soda solution for neutralization, and collect flushings and wash water for disposal. Do not allow phenol to enter sewers, watersheds, or waterways. Follow applicable OSHA regulations (29 CFR 1910.120). Notify proper authorities including the National Response Center (800-424-8802).

**Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

**EPA Designations**

Listed as a RCRA Hazardous Waste (40 CFR 261.33)

Listed as a CERCLA Hazardous Substance* (40 CFR 302.4): Reportable Quantity (RQ), 1000 lb (454 kg) [* per Clean Water Act, Sec. 311(b)(4), Sec. 307(a), and per RCRA, Sec. 3001]

Listed as a SARA Extremely Hazardous Substance (40 CFR 355): RQ, 1000 lb; Threshold Planning Quantity (TPQ), 500/10,000 lb

Listed as a SARA Toxic Chemical (40 CFR 372.65)

**OSHA Designations**

Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A)

## Section 8. Special Protection Data

**Goggles:** Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133).

**Respirator:** Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a NIOSH-approved respirator. Where potential exists for exposures near or over 19 mg/m$^3$, use a MSHA/NIOSH-approved full facepiece respirator with an organic vapor cartridge/canister and dust/mist prefilter. Increased protection is obtained from full facepiece powered-air purifying respirators. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.*

**Other:** Wear impervious gloves, boots, aprons, and gauntlets to prevent skin contact. ACGIH recommends neoprene or butyl rubber as good-to-excellent protective materials.

**Ventilation:** Provide general and local exhaust ventilation systems to maintain airborne concentrations below the OSHA PEL and ACGIH TLV (Sec. 2). Local exhaust ventilation is preferred since it prevents contaminant dispersion into the work area by controlling it at its source.[103]

**Safety Stations:** Make available in the work area emergency eyewash stations, safety/quick-drench showers, and washing facilities.

**Contaminated Equipment:** Never wear contact lenses in the work area: soft lenses may absorb, and all lenses concentrate, irritants. Remove this material from your shoes and equipment. Launder contaminated clothing before wearing.

**Comments:** Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

## Section 9. Special Precautions and Comments

**Storage Requirements:** Store in closed containers in a cool, dry, well-ventilated area away from heated surfaces, open flame, and ignition sources. Outside or detached storage is preferred. Protect containers from physical damage.

**Engineering Controls:** Enclose all operations, eliminating all possible phenol exposure routes. Educate workers about phenol's hazards and potential dangers. Use only with appropriate personal protective gear and adequate ventilation. Institute a respiratory protection program that includes regular training, maintenance, inspection, and evaluation. Provide local exhaust ventilation at the site of chemical release. Practice good personal hygiene and housekeeping procedures.

**Medical Surveillance:** Provide preplacement or periodic medical examinations that emphasize central nervous system (CNS), hepatic, renal, and skin. Tests should include BUN, creatinine, LFTs, and urinalysis. Phenol can be detected in urine in free or conjugated forms. The ACGIH biological exposure index (BEI) is 250 mg total phenol/g creatinine or 15 mg/hr.

**Transportation Data (49 CFR 172.101, .102)**

**DOT Shipping Name:** Phenol
**DOT Hazard Class:** Poison B
**ID No.:** UN1671
**DOT Label:** Poison
**DOT Packaging Exceptions:** 173.364
**DOT Packaging Requirements:** 173.369

**IMO Shipping Name:** Phenol
**IMO Hazard Class:** 6.1
**ID No.:** UN1671
**IMO Label:** Poison
**IMDG Packaging Group:** II

*MSDS Collection* References: 1, 2-12, 15, 19, 23, 24, 26, 31, 34, 37, 38, 59, 73, 79, 84, 85, 89, 100, 101, 103, 124, 126, 127, 132, 133, 136, 138-140, 143, 146, 148, 149

Prepared by: MJ Allison, BS; Industrial Hygiene Review: DJ Wilson, CIH; Medical Review: MJ Upfal, MD, MPH; Edited by: JR Stuart, MS

# Material Safety Data Sheet

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GENIUM PUBLISHING CORP.

No. 181

SILVER

Issued: April 1986

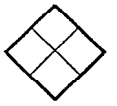
## SECTION 1. MATERIAL IDENTIFICATION

MATERIAL NAME: SILVER
DESCRIPTION: Elemental metal.
OTHER DESIGNATIONS: Ag, Argentum, CAS #7440-22-4.

MANUFACTURER/SUPPLIER: Available from many suppliers.

COMMENTS: Photography products account for 30% of industrial consumption. Additional uses include electrical conductors, coins, silverware, and jewelry.

HMIS
H:1
F:0
R:0
PPE*
*See sect. 8



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## SECTION 2. INGREDIENTS AND HAZARDS

| | % | HAZARD DATA |
|---|---|---|
| Silver, Ag | 99+ | TWA 0.1 mg/m$^3$* |
| | | TWA 0.01 mg/m$^3$** |
| | | --- |
| * Current (1985-86) ACGIH TLV for silver dust and fume. | | Rat, Implant, TD: 2570 mg/kg |
| ** Current (1985-86) ACGIH TLV for soluble silver compounds and OSHA exposure limit. | | |

## SECTION 3. PHYSICAL DATA

Boiling Point ... 3833.6°F (2112°C)
Vapor Pressure ... Not Found
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... Not Found
Evaporation Rate ... Not Found

Specific Gravity ($H_2O$ = 1) ... 10.5
Melting Point ... 1763.4°F (961.9°C)
Percent Volatile by Volume ... Not Found
Molecular Weight ... 107.87

Appearance and odor: Ductile and malleable lustrous white metal.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temp. | Flammability Limits In Air | LOWER | UPPER |
|---|---|---|---|---|
| Not Found | Not Found | Not Found | Not Applicable | Not Applicable |

NFPA Classification: Noncombustible.

EXTINGUISHING MEDIA: Use proper extinguisher for surrounding fire.

UNUSUAL FIRE/EXPLOSION HAZARDS: None.

SPECIAL FIRE-FIGHTING PROCEDURES: None.

## SECTION 5. REACTIVITY DATA

Silver is stable. Hazardous polymerization cannot occur.

CHEMICAL INCOMPATIBILITIES: Acetylene and silver form an insoluble, explosive acetylide. If silver is treated with nitric acid in the presence of ethyl alcohol, silver fulminate may be formed, which can be detonated. Ethylenimine forms explosive compounds with silver. Finely divided silver and hydrogen peroxide solutions may explode. This material is incompatible with oxalic and tartaric acid. Ammonia plus silver may form explosive compounds. Bromoazide explodes on contact with silver foil.

## SECTION 6. HEALTH HAZARD INFORMATION | TLV

Silver is not considered a carcinogen by the NTP, IARC, or OSHA.
SUMMARY OF RISKS: Silver has no known physiological function in man and will accumulate in most tissues. Chronic accumulation (threshold in excess of 1 gram) in the body can result in argyria, a permanent condition associated with widespread bluish pigmentation of the skin and conjunctiva. TARGET ORGANS: Generally, where contact occurs. PRIMARY ENTRY: Inhalation, long-term handling (causes particles to become embedded in skin), or absorption through sweat glands. ACUTE EFFECTS are associated with soluble silver compounds that may be caustic, causing local irritations or destruction of tissue, depending upon strength of solution. CHRONIC EFFECTS: Argyria may be a local or general effect, depending upon previous exposure. FIRST AID: EYE CONTACT: Flush with water for 15 minutes. Get medical attention.* SKIN CONTACT: Wash skin with soap and water. Argyria from long-term exposure is permanent and cannot be washed away. INHALATION: Remove victim to fresh air. INGESTION: Dilute with water. Get medical attention.*

* GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

COMMENTS: The original 0.01 $mg/m^3$ TLV was established to prevent a lifetime body accumulation exceeding 1 gram, where argyria would become evident. Evaluation of 25 years of data has shown 0.01 $mg/m^3$ to be too conservative; therefore, the ACGIH raised the TLV to 0.1 $mg/m^3$.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel; prevent entry into sewers or surface waters. Wear respirator where a dusting hazard is anticipated.

WASTE DISPOSAL: Reclaim or sell waste to a commercial reclaimer.

## SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES are not required unless metal is in the molten state.
GLOVES: Repeated handling may discolor the skin because of skin rubbing against the metal. Cotton gloves will prevent this cosmetic effect.
RESPIRATOR is required where metal dust or fumes are generated with inadequate exhaust ventilation. Air samples should be collected to quantify the exposure levels.
VENTILATION is required where air exposures exceed the TLV-TWA'S.
OTHER: Reclamation of silver from photographic or X-ray film may involve cyanide compounds. Proper precautions must be taken when working with cyanide compounds. See Genium MSDS #13, Potassium Cyanide, for further information.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Silver is usually stored in locked cabinets or safes to prevent theft.

ENGINEERING CONTROLS: Exhaust ventilation where TLV-TWA is exceeded.

EPA Hazardous Substance Designation: 40 CFR 260

Data Source(s) Code: 2, 4, 6, 14, 59, 82, 84, NFC 1983. DW





Approvals

Indust. Hygiene/Safety

Medical Review

# Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 313

PERCHLOROETHYLENE
(Revision D)
Issued: November 1978
Revised: August 1988

## SECTION 1. MATERIAL IDENTIFICATION

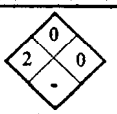


**Material Name:** PERCHLOROETHYLENE

**Description (Origin/Uses):** Used in commercial dry cleaning and metal-degreasing operations; used to a lesser extent in home products and in veterinary anthelmintics (worming).

**Other Designations:** Ethylene Tetrachloride; Tetrachloroethylene; $C_2Cl_4$; CAS No. 0127-18-4

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

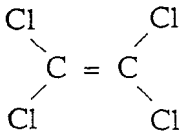



NFPA

| HMIS | |
|---|---|
| H 1 | |
| F 0 | R 1 |
| R 1 | I 3 |
| PPG* | S 2 |
| *See sect. 8 | K 0 |

## SECTION 2. INGREDIENTS AND HAZARDS

Perchloroethylene, CAS No. 0127-18-4




*See NIOSH, *RTECS* (No. KX3850000), for additional data with references to reproductive, irritative, tumorigenic, and mutagenic effects.

| % | EXPOSURE LIMITS |
|---|---|
| Ca 100 | **OSHA PEL**<br>8-Hr TWA: 100 ppm<br>Ceiling: 200 ppm<br>Maximum Peak above the Ceiling: 300 ppm for 5 min. in any 3 Hrs<br>**ACGIH TLVs, 1987-88**<br>TLV-TWA: 50 ppm, 340 mg/m³<br>TLV-STEL: 200 ppm, 1340 mg/m³<br>**Toxicity Data***<br>Human, Inhalation, $TC_{Lo}$: 96 ppm/7 Hrs |

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 250°F (121°C)
**Specific Gravity ($H_2O$ = 1):** 1.623
**% Volatile by Volume:** 100

**Water Solubility (%):** Insoluble
**Molecular Weight:** 166 Grams/Mole
**Vapor Pressure:** 19 Torrs at 77°F (25°C)
**Vapor Density (Air = 1):** 5.83

**Appearance and Odor:** A clear, colorless liquid; ethereal odor.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| * | * | % by Volume | * | * |

**Extinguishing Media:** *Perchloroethylene does not burn. Use extinguishing agents that will put out the surrounding fire.

**Unusual Fire or Explosion Hazards:** Perchloroethylene vapor is heavier than air and it collects in low-lying areas such as sumps, wells, and underground piping systems. Enter these low-lying areas with appropriate caution.

**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode. Use care in selecting safety equipment (see sect. 5, Conditons to Avoid).

## SECTION 5. REACTIVITY DATA

Perchloroethylene is stable in closed containers during routine operations. It does not undergo hazardous polymerization.

**Chemical Incompatibilities:** Hazardous chemical reactions involving perchloroethylene and barium, beryllium, or lithium are reported in Genium reference 84, page 491M-208.

**Conditions to Avoid:** Prevent contact with incompatible chemicals. Avoid exposure to direct sunlight. Monitor the stabilizer level in the perchloroethylene product; get specifications from your supplier for the proper inhibitor levels. This material forms hydrochloric acid (HCl) if the inhibitor level becomes too low. Do not mix perchloroethylene with caustic soda or potash. This material may degrade or attack rubber and some plastics and coatings, so select protective gear and handling equipment carefully.

**Hazardous Products of Decomposition:** Although perchloroethylene itself does not burn, it can be very hazardous in fires because of thermooxidative degradation at high temperatures to very toxic phosgene and corrosive hydrogen chloride. Electric arcs and perchloroethylene vapor may also produce these products of hazardous decomposition.

## SECTION 6. HEALTH HAZARD INFORMATION

Perchloroethylene is not listed as a carcinogen by the NTP, IARC, or OSHA.

**Summary of Risks:** Perchloroethylene affects the central nervous system (CNS), causing incoordination, headache, vertigo, light narcosis, dizziness, unconsciousness, and even death. All of these can occur as the level and duration of exposure continues.

**Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** CNS, eyes, skin.
**Primary Entry:** Inhalation, skin. **Acute Effects:** Irritation of the skin, eyes, and upper respiratory tract (URT); CNS effects.
**Chronic Effects:** None reported.

**FIRST AID**
**Eyes:** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes.
**Skin:** Immediately wash the affected area with soap and water.
**Inhalation:** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed.
**Ingestion:** Never give anything by mouth to someone who is unconscious or convulsing. Do not induce vomiting.

**GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.**

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, provide ventilation, and eliminate all sources of ignition immediately. Cleanup personnel need protection against contact with and inhalation of vapor (see sect. 8). Contain large spills and collect waste or absorb it with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place waste liquid or absorbent into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**
Air Contaminant (29 CFR 1910.1000 Subpart Z)

**EPA Designations (40 CFR 302.4)**
RCRA Hazardous Waste, No. U210
CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Clean Water Act (CWA), section 307 (a) and Resource Conservation and Recovery Act (RCRA), section 3001

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing of perchloroethylene solution may occur, wear a full face shield/splash guard. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirator protection. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (e.g., cleaning reactor vessels or storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with perchloroethylene. Suggested material includes polyvinyl alcohol, polyethylene, or neoprene. Leather shoes are also appropriate. **Ventilation:** Install and operate general and local ventilation systems that are powerful enough to maintain airborne levels of perchloroethylene dust below the OSHA PEL standard cited in section 2. **Safety Stations:** Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from shoes and equipment.
**Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Avoid inhaling perchloroethylene vapor. Select safety equipment carefully (see sect. 5, Conditions to Avoid).

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store perchloroethylene in a cool, dry, well-ventilated area away from barium, beryllium, and lithium.

**Special Handling/Storage:** Protect containers from physical damage. Fit all holding tanks with an air-drying venting system that prevents moist air from entering the tank and allows for perchloroethylene vapor expansion and contraction; airtight storage facilities are not recommended. Aluminum is not recommended for storage facilities.

**Transportation Data (49 CFR 172.101-2)**

| | | |
|---|---|---|
| **DOT Shipping Name:** Tetrachloroethylene | **DOT Label:** None | **IMO Label:** Saint Andrew's Cross (X)* |
| **DOT ID No.** UN1897 | **DOT Hazard Class:** ORM-A | **IMO Class:** 6.1 |

*Harmful-Stow away from Foodstuffs (Materials of IMO Class 6.1, Packaging Group III).

**References:** 1, 12, 73, 84-94, 100, 103.



Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

# Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 317
TOLUENE
(Revision D)

Issued: August 1979
Revised: April 1986

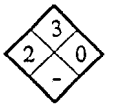
## SECTION 1. MATERIAL IDENTIFICATION 20

MATERIAL NAME: TOLUENE

OTHER DESIGNATIONS: Methyl Benzene, Methyl Benzol, Phenylmethane, Toluol, $C_7H_8$, CAS #0108-88-3

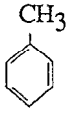
MANUFACTURER/SUPPLIER: Available from many suppliers, including:
Allied Corp., PO Box 2064R, Morristown, NJ 07960; Telephone: (201) 455-4400
Ashland Chemical Co., Industrial Chemicals & Solvents Div., PO Box 2219,
Columbus, OH; Telephone: (614) 889-3844

HMIS
H: 2
F: 3
R: 0
PPE*
*See sect. 8




R 1
I 3
S 2
K 4

## SECTION 2. INGREDIENTS AND HAZARDS

| | % | HAZARD DATA |
|---|---|---|
| Toluene  | ca 100 | 8-hr TLV: 100 ppm, or 375 mg/m$^3$* (Skin)**<br>---<br>Man, Inhalation, TCLo: 100 ppm: Psychotropic***<br>---<br>Rat, Oral, $LD_{50}$: 5000 mg/kg<br>Rat, Inhalation, LCLo: 4000 ppm/4 hrs.<br>Rabbit, Skin, $LD_{50}$: 14 gm/kg<br>---<br>Human, Eye: 300 ppm |



* Current (1985-86) ACGIH TLV. The OSHA PEL is 200 ppm with an acceptable ceiling concentration of 300 ppm and an acceptable maximum peak of 500 ppm/10 minutes.

** Skin designation indicates that toluene can be absorbed through intact skin and contribute to overall exposure.

*** Affects the mind.

## SECTION 3. PHYSICAL DATA

Boiling Point ... 231°F (111°C)
Vapor Pressure @ 20°C, mm Hg ... 22
Water Solubility @ 20°C, wt. % ... 0.05
Vapor Density (Air = 1) ... 3.14

Evaporation Rate (BuAc = 1) ... 2.24
Specific Gravity ($H_2O$ = 1) ... 0.866
Melting Point ... -139°F (-95°C)
Percent Volatile by Volume ... ca 100
Molecular Weight ... 92.15

Appearance and odor: Clear, colorless liquid with a characteristic aromatic odor. The odor is detectable to most individuals in the range of 10 to 15 ppm. Because olfactory fatigue occurs rapidly upon exposure to toluene, odor is not a good warning property.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temp. | Flammability Limits In Air | LOWER | UPPER |
|---|---|---|---|---|
| 40°F (4°C) CC | 896°F (480°C) | % by Volume | 1.27 | 7.1 |

EXTINGUISHING MEDIA: Carbon dioxide, dry chemical, alcohol foam. Do not use a solid stream of water because the stream will scatter and spread the fire. Use water spray to cool tanks/containers that are exposed to fire and to disperse vapors.

UNUSUAL FIRE/EXPLOSION HAZARDS: This OSHA class IB flammable liquid is a dangerous fire hazard. It is a moderate fire hazard when exposed to oxidizers, heat, sparks, or open flame. Vapors are heavier than air and may travel a considerable distance to an ignition source and flash back.

SPECIAL FIRE-FIGHTING PROCEDURES: Fire fighters should wear self-contained breathing apparatus with full facepiece operated in a positive-pressure mode when fighting fires involving toluene.

## SECTION 5. REACTIVITY DATA

CHEMICAL INCOMPATIBILITIES: Toluene is stable in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization. This material is incompatible with strong oxidizing agents, dinitrogen tetraoxide, silver perchlorate, tetranitromethane, and uranium hexafluoride. Contact with these materials may cause fire or explosion. Nitric acid and toluene, especially in the presence of sulfuric acid, will produce nitrated compounds that are dangerously explosive.

CONDITIONS TO AVOID: Avoid exposure to sparks, open flame, hot surfaces, and all sources of heat and ignition. Toluene will attack some forms of plastics, rubber, and coatings. Thermal decomposition or burning produces carbon dioxide and/or carbon monoxide.

## SECTION 6. HEALTH HAZARD INFORMATION | TLV

Toluene is not considered a carcinogen by the NTP, IARC, or OSHA. SUMMARY OF RISKS: Vapors of toluene may cause irritation of the eyes, nose, upper respiratory tract, and skin. Exposure to 200 ppm for 8 hours causes mild fatigue, weakness, confusion, lacrimation (tearing) and paresthesia (a sensation of prickling, tingling, or creeping on the skin that has no objective cause). Exposure to higher concentrations may cause headache, nausea, dizziness, dilated pupils, and euphoria, and, in severe cases, may cause unconsciousness and death. The liquid is irritating to the eyes and skin. Contact with the eyes may cause transient corneal damage, conjunctival irritation, and burns if not promptly removed. Repeated and/or prolonged contact with the skin may cause drying and cracking. It may be absorbed through the skin in toxic amounts. Ingestion causes irritation of the gastrointestinal tract and may cause effects resembling those from inhalation of the vapor. Chronic overexposure to toluene may cause reversible kidney and liver injury. FIRST AID: EYE CONTACT: Immediately flush eyes, including under eyelids, with running water for at least 15 minutes. Get medical attention if irritation persists.* SKIN CONTACT: Immediately flush skin (for at least 15 minutes) while removing contaminated shoes and clothing. Wash exposed area with soap and water. Get medical attention if irritation persists or if a large area has been exposed.* INHALATION: Remove victim to fresh air. Restore and/or support breathing as required. Keep victim warm and quiet. Get medical help.* INGESTION: Give victim 1 to 2 glasses of water or milk. Contact a poison control center. Do not induce vomiting unless directed to do so. Transport victim to a medical facility. Never give anything by mouth to a person who is unconscious or convulsing. * GET MEDICAL ASSISTANCE = In plant, paramedic, community. Get medical help for further treatment, observation, and support after first aid, if indicated.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Notify safety personnel of large spills or leaks. Remove all sources of heat and ignition. Provide maximum explosion-proof ventilation. Limit access to spill area to necessary personnel only. Remove leaking containers to safe place if feasible. Cleanup personnel need protection against contact with liquid and inhalation of vapor (see sect. 8). WASTE DISPOSAL: Absorb small spills with paper towel or vermiculite. Contain large spills and collect if feasible, or absorb with vermiculite or sand. Place waste solvent or absorbent into closed containers for disposal using nonsparking tools. Liquid can be flushed with water to an open holding area for handling. Do not flush to sewer, watershed, or waterway. COMMENTS: Place in suitable container for disposal by a licensed contractor or burn in an approved incinerator. Consider reclaiming by distillation. Contaminated absorbent can be buried in a sanitary landfill. Follow all Federal, state, and local regulations. TLm 96: 100-10 ppm. Toluene is designated as a hazardous waste by the EPA. The EPA (RCRA) HW No. is U220 (40 CFR 261). The reportable quantity (RQ) is 1000 lbs/454 kg (40 CFR 117).

## SECTION 8. SPECIAL PROTECTION INFORMATION

Provide general and local exhaust ventilation to meet TLV requirements. Ventilation fans and other electrical service must be nonsparking and have an explosion-proof design. Exhaust hoods should have a face velocity of at least 100 lfm (linear feet per minute) and be designed to capture heavy vapor. For emergency or nonroutine exposures where the TLV may be exceeded, use an organic chemical cartridge respirator if concentration is less than 200 ppm and an approved canister gas mask or self-contained breathing apparatus with full facepiece if concentration is greater than 200 ppm.
Safety glasses or splash goggles should be worn in all work areas. Neoprene gloves, apron, face shield, boots, and other appropriate protective clothing and equipment should be available and worn as necessary to prevent skin and eye contact. Remove contaminated clothing immediately and do not wear it until it has been properly laundered.

Eyewash stations and safety showers should be readily available in use and handling areas.

Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Store in a cool, dry, well-ventilated area away from oxidizing agents, heat, sparks, or open flame. Storage areas must meet OSHA requirements for class IB flammable liquids. Use metal safety cans for handling small amounts. Protect containers from physical damage. Use only with adequate ventilation. Avoid contact with eyes, skin, or clothing. Do not inhale or ingest. Use caution when handling this compound because it can be absorbed through intact skin in toxic amounts. SPECIAL HANDLING/STORAGE: Ground and bond metal containers and equipment to prevent static sparks when making transfers. Do not smoke in use or storage areas. Use nonsparking tools. ENGINEERING CONTROLS: Preplacement and periodic medical exams emphasizing the liver, kidneys, nervous system, lungs, heart, and blood should be provided. Workers exposed to concentrations greater than the action level (50 ppm) should be examined at least once a year. Use of alcohol can aggravate the toxic effects of toluene.
COMMENTS: Emptied containers contain product residues. Handle accordingly!
Toluene is designated as a hazardous substance by the EPA (40 CFR 116). DOT Classification: Flammable liquid. UN1294.
Data Source(s) Code: 1-9, 12, 16, 20, 21, 24, 26, 34, 81, 82. CR





Approvals

Indust. Hygiene/Safety

Medical Review

# Material Safety Data Sheet

from Genium's Reference Collection
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GENIUM PUBLISHING CORP.

No. 311

METHYL CHLOROFORM
(Revision E)
Issued: November 1975
Revised: November 1988

## SECTION 1. MATERIAL IDENTIFICATION 27

**Material Name:** METHYL CHLOROFORM

**Description (Origin/Uses):** Used in cold-type metal cleaning; also in cleaning plastic molds.

**Other Designations:** 1,1,1-Trichloroethane; $CH_3CCl_3$; CAS No. 0071-55-6

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

HMIS
H 2 R 1
F 0 I –
R 1 S 2
PPG* K 1
*See sect. 8

NFPA

## SECTION 2. INGREDIENTS AND HAZARDS/EXPOSURE LIMITS

Methyl Chloroform, CAS No. 0071-55-6

| OSHA PELs | ACGIH TLVs, 1988-89 | Toxicity Data** |
|---|---|---|
| 8-Hr TWA: 350 ppm, 1900 mg/m³ | TLV-TWA: 350 ppm, 1900 mg/m³ | Man, Inhalation, $LC_{Lo}$: 27 g/m³ (10 Mins) |
| STEL: 450 ppm, 2450 mg/m³ | TLV-STEL: 450 ppm, 2450 mg/m³ | Man, Inhalation, $TC_{Lo}$: 350 ppm |
| | | Human, Oral, $TD_{Lo}$: 670 mg/kg |
| | | Rat, Oral, $LD_{50}$: 10300 mg/kg |

*Contact your supplier for specifications, including details about inhibitors that can be added to the methyl chloroform product.
**See NIOSH, *RTECS* (KJ2975000), for additional data with references to irritative, reproductive, and mutagenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 165°F (74.1°C)
**Melting Point:** -26.5°F (-32.5°C)
**Vapor Density (Air = 1):** 4.55
**Vapor Pressure:** 100 Torrs at 68°F (20°C)
**Molecular Weight:** 133 Grams/Mole
**Solubility in Water (%):** Insoluble
**Specific Gravity ($H_2O$ = 1):** 1.3376 at 68°F (20°C)
**% Volatile by Volume:** Ca 100

**Appearance and Odor:** A colorless liquid; mild, sweetish, pleasant, etherlike odor that may be just perceptible (if unfatigued) at about 100 ppm in the air.

**Comments:** Small variations in the above-noted physical properties are expected because of the various inhibitors that may be included in the methyl chloroform product.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point: None Found | Autoignition Temperature: 998°F (537°C) | LEL: 8.0% v/v | UEL: 10.5% v/v |
|---|---|---|---|

**Extinguishing Media:** Methyl chloroform does not burn at ordinary temperatures. High-energy sources such as an electric arc or an elevated temperature are required for ignition of this material. When the source of ignition is removed, methyl chloroform tends to stop burning. Use water spray to cool fire-exposed containers. Use water fog, carbon dioxide, dry chemical, or foam to fight fires involving this material or nearby fires. **Unusual Fire or Explosion Hazards:** Methyl chloroform vapor is heavier than air and may travel a considerable distance to a low-lying high-energy source of ignition and flash back to its origin. Use care in selecting equipment (see sect. 5, Comments). **Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

**Stability/Polymerization:** Methyl chloroform is stable in closed containers during routine operations. Hazardous polymerization cannot occur. **Chemical Incompatibilities:** Methyl chloroform can react dangerously with acetone, nitrogen tetroxide, oxygen (gas or liquid), sodium, sodium hydroxide, and sodium-potassium alloys. **Conditions to Avoid:** Avoid exposure to any high-energy source of ignition or to incompatible chemicals. **Hazardous Products of Decomposition:** Toxic and corrosive gases such as hydrogen chloride, dichloracetylene, chlorine, and phosgene can be produced by decomposition of methyl chloroform at high temperatures, contact with hot metals, or exposure to ultraviolet radiation. Phosgene is usually produced in very small quantities; however, the significant irritating properties of hydrogen chloride (the dominant product of decomposition) prevent significant exposure to the phosgene. **Comments:** This material can be hydrolyzed by water to form hydrochloric acid and acetic acid. It will react with strong caustics to form flammable or explosive materials. It attacks natural rubber. Methyl chloroform requires an inhibitor content to prevent corrosion of metals. When the inhibitor is depleted, this material can decompose rapidly by reaction with finely divided white metals such as aluminum, magnesium, or zinc. Do not use these metals in pressurized spraying equipment where methyl chloroform is involved.

## SECTION 6. HEALTH HAZARD INFORMATION

**Carcinogenicity:** Methyl chloroform is not listed as a carcinogen by the NTP, IARC, or OSHA.
**Summary of Risks:** Methyl chloroform exhibits low oral toxicity. It can defat the exposed skin of workers and cause redness and scaling. Although methyl chloroform is low in systemic toxicity, it is an anesthetic that is capable of causing death if it is inhaled at concentrations of 14000 to 15000 ppm. Fatalities that have occurred in poorly ventilated areas such as pits or tanks are attributed to anesthesia and/or sensitization of the myocardium to epinephrine. Quick and complete recovery is reported upon prompt removal of unconscious exposed persons from the area of exposure. The TLV-TWA cited in section 2 is set to prevent initial anesthetic effects and/or objections to the

## SECTION 6. HEALTH HAZARD INFORMATION, cont.

odor. **Medical Conditions Aggravated by Long-Term Exposure:** None reported. **Target Organs:** Skin, eyes, heart, cardiovascular system, and CNS. **Primary Entry:** Inhalation, skin absorption. **Acute Effects:** Headache, lassitude, dermatitis, skin and eye irritation, cardiac arrhythmias, and depression of the CNS. **Chronic Effects:** None reported. **FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with flooding amounts of running water for at least 15 minutes. **Skin.** Rinse the affected area with flooding amounts of water, then wash it with soap and water. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. Have qualified medical personnel administer oxygen as required. **Ingestion.** Unlikely. Should this type of exposure occur, medical help is not readily available, and the amount swallowed was appreciable, give the exposed person milk of magnesia to drink and induce vomiting. Repeat this procedure. Aspiration hazards exist, so the decision whether or not to induce vomiting must be made carefully. If vomiting is to be induced, carry it out as quickly as possible before the ingested methyl chloroform is internally absorbed. This procedure would increase the chance of aspiration. **Get medical help (in plant, paramedic, community) for all exposures.** Seek prompt medical assistance for further treatment, observation, and support after first aid. **Note to Physician:** The estimated lethal dose by ingestion for a man weighing 150 pounds is 0.5 to 1 pint. Do not use adrenalin or sympathomimetic amines in treatment because of the increased cardiac sensitivity involved. Ingestion may cause spontaneous vomiting.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** Notify safety personnel, evacuate unnecessary personnel, eliminate all sources of ignition immediately, and provide adequate explosion-proof ventilation. Cleanup personnel need protection against skin or eye contact with this liquid as well as inhalation of its vapor (see sect. 8). Contain large spills and collect or absorb waste with an inert material such as sand, earth, or vermiculite. Use nonsparking tools to place liquid or absorbent waste into closable containers for disposal. Keep waste out of sewers, watersheds, and waterways. **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations. Follow Federal, state, and local regulations.

**OSHA Designations**
Listed as an Air Contaminant (29 CFR 1910.1000 Subpart Z).
**EPA Designations (40 CFR 302.4)**
RCRA Hazardous Waste, No. U226
CERCLA Hazardous Substance, Reportable Quantity: 1000 lbs (454 kg), per the Resource Conservation and Recovery Act, § 3001.

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Where splashing is possible, wear a full face shield. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Use a NIOSH-approved respirator per Genium reference 88 for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine operations (spills or cleaning reactor vessels and storage tanks), wear an SCBA. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves, boots, aprons, and gauntlets, etc., to prevent prolonged or repeated skin contact with this material. Suggested materials include neoprene, polyvinyl alcohol, or polyethylene. Natural rubber is not recommended. **Ventilation:** Install and operate general and local maximum, explosion-proof ventilation systems powerful enough to maintain airborne levels of this material below the OSHA PEL standard cited in section 2. Local exhaust ventilation is preferred because it prevents dispersion of the contaminant into the general work area by eliminating it at its source. Consult the latest edition of Genium reference 103 for detailed recommendations. **Safety Stations:** Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work areas. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. Remove contaminated clothing and launder it before wearing it again; clean this material from your shoes and equipment. **Other:** Exercise care in the selection of safety and handling equipment because methyl chloroform attacks natural rubber. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Keep it off your clothing and equipment. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area. Do not inhale methyl chloroform vapor. Consider functions of the CVS, CNS, liver, and skin while administering preplacement and periodic medical exams.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store methyl chloroform in closed containers in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals (see sect. 5). Protect containers from physical damage. Steel is a recommended material for storage containers. **Special Handling/Storage:** Prevent moisture contamination of storage facilities. Monitor levels of inhibitor. Use caution in cleaning operations involving white metal fines (see sect. 5). **Engineering Controls:** Make sure all engineering systems (production, transportation) are of maximum, explosion-proof design. Electrically ground and bond all containers and pipelines, etc., used in shipping, transferring, reacting, production, and sampling operations to prevent generating static sparks. **Other:** Personnel who regularly work with methyl chloroform should avoid drinking alcoholic beverages shortly before, during, or after exposure.

**Transportation Data (49 CFR 172.101-2)**

**DOT Shipping Name:** 1,1,1-Trichloroethane
**DOT Hazard Class:** ORM-A
**ID No.** UN2831
**DOT Packaging Requirements:** 49 CFR 173.605
**DOT Packaging Exceptions:** 49 CFR 173.605

**IMO Shipping Name:** 1,1,1-Trichloromethane
**IMO Hazard Class:** 6.1
**IMO Label:** Saint Andrew's Cross (X)*
**IMDG Packaging Group:** III

*Harmful-Stow away from Foodstuffs (Materials of Class 6.1 Packaging Group III).

**References:** 1, 38, 84-94, 116, 117, 120, 122.



Prepared by PJ Igoe, BS
Industrial Hygiene Review: DJ Wilson, CIH
Medical Review: MJ Hardies, MD

# Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
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GENIUM PUBLISHING CORP.

No. 312
TRICHLOROETHYLENE
(Revision E)

Issued: July 1979
Revised: August 1987

## SECTION 1. MATERIAL IDENTIFICATION



MATERIAL NAME: TRICHLOROETHYLENE

DESCRIPTION (Origin/Uses): Prepared from *sym*-tetrachloroethane by way of eliminating HCl by boiling with lime. Used to manufacture organic chemicals, pharmaceuticals; in degreasing and dry cleaning; and as a solvent for fats, waxes, rubbers, oils, paints, varnishes, ethers, and cellulose esters.


OTHER DESIGNATIONS: Ethylene Trichloride; TCE; Trichloroethene; 1,1,2-Trichloroethylene; $C_2HCl_3$; NIOSH *RTECS* #KX4550000; CAS #0079-01-6

MANUFACTURER/SUPPLIER: Available from several suppliers, including:
Dow Chemical USA, 2020 Dow Center, Midland, MI 48640;
Telephone: (517) 636-1000; (800) 258-CHEM

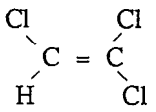
COMMENTS: Trichloroethylene is a toxic solvent and a suspected occupational carcinogen.

| HMIS | | | |
|---|---|---|---|
| H | 2 | R | 1 |
| F | 1 | I | 3 |
| R | 1 | S | 1 |
| PPE* | | K | 0 |

* See sect. 8

## SECTION 2. INGREDIENTS AND HAZARDS

| | % | HAZARD DATA |
|---|---|---|
| Trichloroethylene, CAS #0079-01-6; NIOSH *RTECS* #KX4550000 | 100 | ACGIH Values 1987-88<br>TLV-TWA*: 50 ppm, 270 mg/m$^3$<br>TLV-STEL**: 200 ppm, 1080 mg/m$^3$<br>OSHA PEL 1986***<br>8-Hr TWA: 100 ppm<br>Ceiling: 200 ppm<br>NIOSH REL 1986<br>10-Hr TWA: 25 ppm<br>TOXICITY DATA<br>Human, Oral, $LD_{Lo}$: 7 g/kg<br>Human, Inhalation, $TC_{Lo}$: 6900 mg/m$^3$ (10 Min)<br>Human, Inhalation, $TC_{Lo}$: 160 ppm/83 Min<br>Human, Inhalation, $TD_{Lo}$: 812 mg/kg |




* The TLV-TWA is set to control subjective complaints such as headache, fatigue, and irritability.

** The TLV-STEL is set to prevent incoordination and other beginning anesthetic effects from TCE. These levels should provide a wide margin of safety in preventing liver injury.

*** The OSHA PEL is 300 ppm for 5 minutes in any 2 hours.

## SECTION 3. PHYSICAL DATA

Boiling Point ... 188.6°F (87°C)
Vapor Pressure ... 58 Torr at 68°F (20°C)
Water Solubility ... Insoluble
Vapor Density (Air = 1) ... 4.53
Evaporation Rate ... Not Listed
Specific Gravity ... 1.4649 at 68°F (20°C)
Melting Point ... -120.64°F (-84.8°C)
Molecular Weight ... 131.40 Grams/Mole

Appearance and odor: Colorless, nonflammable mobile liquid; sweetish odor like chloroform.

COMMENTS: TCE is highly soluble in lipids. A high vapor pressure at room temperature provides the potential for TCE vapors to contaminate use areas.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| Not Listed | 770°F (410°C) | % by Volume | 8% | 10.5% |

EXTINGUISHING MEDIA: TCE has no flash point in a conventional closed tester at room temperature, but it is moderately flammable at higher temperatures. Use dry chemical, carbon dioxide, alcohol foam, or other extinguishing agents suitable for the surrounding fire.

OSHA Flammability Class (29 CFR 1910.106): Not Regulated

UNUSUAL FIRE/EXPLOSION HAZARDS: During fire conditions TCE emits highly toxic and irritating fumes, including hydrochloric acid and phosgene. SPECIAL FIRE-FIGHTING PROCEDURES: Wear a self-contained breathing apparatus with a full facepiece operated in a pressure-demand or another positive-pressure mode. At TCE vapor levels of 300-1000 ppm, fire fighters who lack the proper respiratory equipment may experience incoordination and impaired judgment.

DOT Flammability Class (49 CFR 173.115): Not Regulated

## SECTION 5. REACTIVITY DATA

Trichloroethylene is stable. Hazardous polymerization can occur under certain circumstances (see Conditions to Avoid and Comments, below).

CHEMICAL INCOMPATIBILITIES include magnesium or aluminum powder, NaOH, KOH, or other strong alkaline materials. Reactions with alkaline materials may lead to the formation of dangerous explosive mixtures of chloroacetylenes.

CONDITIONS TO AVOID: When TCE is heated (as in the case with vapor degreasers) or exposed to sunlight, it requires extra stabilization against oxidation, degradation, and polymerization. It is slowly decomposed by light when moist.

PRODUCTS OF HAZARDOUS DECOMPOSITION include hydrochloric acid and phosgene under certain conditions at elevated temperatures.

COMMENTS: TCE is stable under normal handling and storage conditions, and hazardous polymerization is not expected to occur. However, failure of the stabilizer at elevated temperatures or other extreme conditions may allow polymerization to take place..

## SECTION 6. HEALTH HAZARD INFORMATION

Trichloroethylene is listed as a carcinogen by the NTP, IARC, and OSHA. NIOSH recommends that trichloroethylene be treated as an occupational carcinogen. IARC carcinogenic results are animal suspect, animal positive, and human indefinite. SUMMARY OF RISKS: Moderate exposures to TCE cause symptoms similar to those of alcohol inebriation. Higher concentrations cause narcotic effects. Ventricular fibrillation has been cited as the cause of death following heavy exposures. TCE-induced hepato cellular carcinomas have been detected in mice during tests conducted by the National Cancer Institute (*Chem & Eng News* 54 [April 5, 1976]:4). Organ systems affected by overexposure to TCE are the central nervous system (euphoria, analgesia, anesthesia), degeneration of the liver and kidneys, the lungs (tachypnea), heart (arrhythmia) and skin (irritation, vesication, and paralysis of fingers when immersed in liquid TCE). Contact with the liquid defats the skin, causing topical dermatitis. Certain people appear to experience synergistic effects from TCE exposure concomitant with exposure to caffeine, alcohol, and other drugs. When combined with alcohol intake, toxic effects are increased and may cause a red, blotchy facial and upper body rash commonly called "degreaser's flush." Other reported symptoms of TCE exposure include abnormal fatigue, headache, irritability, gastric disturbances, and intolerance to alcohol. Toxic effects from testing of TCE on humans include hallucination, distorted perception, somnolence (general depressed activity), and jaundice. TARGET ORGANS: Respiratory system, central nervous system, heart, liver, kidneys, and skin. PRIMARY ENTRY: Ingestion, inhalation, skin contact. ACUTE EFFECTS: Headache, vertigo, visual disturbance, tremors, nausea, vomiting, dermatitis, dizziness, drowsiness, and irritation to the eyes, nose, and throat. CHRONIC EFFECTS: None Reported. MEDICAL CONDITIONS AGGRAVATED BY LONG-TERM EXPOSURE: Diseases of the liver, kidneys, lungs, and central nervous system. FIRST AID: EYE CONTACT: Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. Get medical help.* SKIN CONTACT: Wash thoroughly with soap and water. Remove and launder contaminated clothing before wearing it again; clean material from shoes and equipment. Get medical help.* INHALATION: Remove victim to fresh air; restore and/or support his breathing as needed. Do not give adrenalin to the victim. Get medical help.* INGESTION: Call a poison control center. Never give anything by mouth to someone who is unconscious or convulsing. A professional decision regarding whether or not to induce vomiting is required. Do not give adrenalin to the victim. Get medical help.*

*GET MEDICAL ASSISTANCE = IN PLANT, PARAMEDIC, COMMUNITY. Get prompt medical assistance for further treatment, observation, and support after first aid.

COMMENTS: Workers' responses to TCE vary significantly because of many factors, including age, health status, nutrition, and intake of alcohol, caffeine, and medicines. Do not use these substances before, during, or after exposure to TCE. If a worker displays any of the symptoms of exposure to TCE, thoroughly investigate all the possible contributing factors to determine, if possible, how much the work environment levels of TCE are responsible.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

SPILL/LEAK: Inform safety personnel of any trichloroethylene spill or leak and evacuate the area for large spills. Cleanup personnel must use respiratory and liquid contact protection. Adequate ventilation must be provided. Confine the spilled TCE to as small an area as possible. Do not allow it to run off to sewers or open waterways. Pick up spilled TCE with a vacuum cleaner or an absorbent such as vermiculite.

DISPOSAL: Consider reclamation, recycling, or destruction rather than disposal in a landfill.

Trichloroethylene is designated as a hazardous substance by the EPA (40 CFR 116.4).

Trichloroethylene is reported in the 1983 EPA TSCA Inventory.

EPA Hazardous Waste Number (40 CFR 261.33): U228

EPA Reportable Quantity (40 CFR 117.3): 1000 lbs (454 kgs)

Aquatic Toxicity Rating, TLm 96: Not Listed

## SECTION 8. SPECIAL PROTECTION INFORMATION

GOGGLES: Always wear protective eyeglasses or chemical safety goggles. Follow the eye and face protection guidelines of 29 CFR 1910.133. GLOVES: Wear impervious gloves. RESPIRATOR: Use a NIOSH-approved respirator per the *NIOSH Guide to Chemical Hazards* (Genium ref. 88) for the maximum-use concentrations and/or the exposure limits cited in section 2. Follow the respirator guidelines in 29 CFR 1910.134. Any detectable concentration of TCE requires an SCBA, full facepiece, and pressure-demand/positive-pressure modes. WARNING: Air-purifying respirators will not protect workers from oxygen-deficient atmospheres. OTHER EQUIPMENT: Wear rubber boots, aprons, and other suitable body protection appropriate to the existing work environment. VENTILATION: Install and operate general and local exhaust ventilation systems of sufficient power to maintain airborne concentrations of TCE below the OSHA PEL standards cited in section 2. SAFETY STATIONS: Make eyewash stations, washing facilities, and safety showers available in areas of use and handling. Contact lenses pose a special hazard; soft lenses may absorb irritants, and all lenses concentrate them. OTHER SPECIAL MODIFICATIONS IN THE WORKPLACE: Because of the unresolved controversy about the carcinogenic status of TCE, all existing personal protective equipment and engineering technology should be used to prevent any possibility of worker contact with this material.

COMMENTS: Practice good personal hygiene. Keep material off of your clothes and equipment. Avoid transfer of material from hands to mouth while eating, drinking, or smoking. Adhere to the sanitation requirements of 29 CFR 1910.141 and 29 CFR 1910.142.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

STORAGE SEGREGATION: Prevent TCE from coming into contact with strong caustics such as NaOH; KOH; chemically active metal like Ba, Li, Na, Mg, Ti; and powdered aluminum or magnesium in acidic solutions. SPECIAL HANDLING/STORAGE: Store this material in a cool, dry, well-ventilated area. Avoid elevated temperatures because products of toxic and corrosive decomposition from TCE may form. Monitor the level of any stabilizer component that may be added to the TCE. (Consult the technical data from the supplier to determine the specifics of any added stabilizer.) If applicable, follow the supplier's recommendation concerning proper rotation of stock, shelf-life requirements, and levels of stabilizers.

ENGINEERING CONTROLS IN THE WORKPLACE: Avoid collecting aluminum fines (very small particles) or chips in a TCE vapor degreaser. Monitor TCE stabilizer levels regularly. Only trained personnel should operate vapor degreasers.

TRANSPORTATION DATA (per 49 CFR 172.101-2):

DOT Hazard Class: ORM-A | DOT ID No. UN1710 | IMO Class: 6.1

IMO Label: St. Andrew's Cross (X)* | DOT Shipping Name: Trichloroethylene | DOT Label: None

* Harmful - Stow away from foodstuffs (IMO Label, Materials of Class 6.1 Packaging Group III).

References: 1-9, 12, 14, 21, 73, 87-94. PI





Approvals JDRocco

Indust. Hygiene/Safety

Medical Review

# Material Safety Data Sheet

Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 309
FLUOROTRICHLORO-METHANE
(Revision C)
Issued: August 1974
Revised: February 1986

## SECTION 1. MATERIAL IDENTIFICATION 19

MATERIAL NAME: FLUOROTRICHLOROMETHANE

OTHER DESIGNATIONS: Trichlorofluoromethane, Propellent 11, $CCl_3F$, Monofluorotrichloromethane, CAS #0075-69-4

Not Found

TRADE NAMES AND MANUFACTURERS: FREON 11 and FREON MF (Du Pont); GENETRON 11 (Allied); ISOTRON 11 (Pennwalt); UCON 11 (Union Carbide).

R 1
I 1
S 1
K 0

## SECTION 2. INGREDIENTS AND HAZARDS

| | % | HAZARD DATA |
|---|---|---|
| FLUOROTRICHLOROMETHANE | ca 100 | 8-hr TWA: 1000 ppm* or 5600 mg/m$^3$<br>---<br>Rat, Inhalation, LCLo: 10 pph/20 min.<br>---<br>Human, Inhalation, $TC_{50}$: 50,000 ppm/30 min. |

* Current OSHA PEL. ACGIH (1985-86) TLV ceiling value.

## SECTION 3. PHYSICAL DATA

Boiling Point, 1 atm ... 74.7°F (23.8°C)
Vapor Pressure @ 70°F, mm Hg ... 690
Vapor Density (Air = 1) ... 5.0
Solubility in Water at 25°C, 1 atm, wt. % ... 0.11
Specific Gravity (17/4°C) ... 1.494

Volatiles, % ... 100
Evaporation Rate (CCl4 = 1) ... 0.1
Freezing Point ... -169°F (-111°C)
Molecular Weight ... 137.37

Appearance and Odor: Colorless, nearly odorless, volatile liquid. At concentrations above 20% in air it has a mild, ethereal odor resembling that of $CCl_4$, (carbon tetrachloride).

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temp. | Flammability Limits In Air | LOWER | UPPER |
|---|---|---|---|---|
| Nonflammable | NA | Nonflammable | NA | NA |

EXTINGUISHING MEDIA: Use whatever is appropriate for surrounding fire.
Fluorotrichloromethane is a nonflammable material. Vapors are five times heavier than air. High concentrations may tend to accumulate in low-lying areas.

Fire fighters should wear self-contained breathing apparatus and fully protective clothing against suffocating vapors and toxic and corrosive decomposition products.

## SECTION 5. REACTIVITY DATA

Fluorotrichloromethane is a very stable material in closed containers at room temperature under normal storage and handling conditions. It does not undergo hazardous polymerization.
Prevent exposure to alkali or alkaline earth metals such as sodium, potassium, etc. Magnesium and aluminum may also be reactive, especially in the finely ground or powdered state or at high temperatures.

Thermal-oxidative degradation can produce toxic and corrosive materials such as halogens, carbonyl halides, and phosgene.

## SECTION 6. HEALTH HAZARD INFORMATION | TLV

High concentrations of fluorotrichloromethane vapors may cause asphyxiation because of dilution of available oxygen in air below levels necessary to sustain life. Symptoms can include lightheadedness, giddiness, disorientation, shortness of breath, and possible cardiac arrhythmias. Vapors may have little or no effect on the eyes. Prolonged or repeated skin contact with liquid may cause defatting of tissue.

FIRST AID: EYE CONTACT: Flush thoroughly with running water for 15 minutes (including under eyelids). SKIN CONTACT: Remove contaminated clothing. Flush affected area with water. INHALATION: Remove to fresh air. Restore and/or support breathing as needed. INGESTION: Seek physician (not expected as a hazard).

Seek prompt medical assistance for further treatment, observation, and support. DO NOT USE epinephrine or similar drugs because they can produce cardiac arrhythmias, including ventricular fibrillation.

Fluorotrichloromethane is not listed as a carcinogen by the NTP, IARC, or OSHA.

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

Notify safety personnel of leaks or spills. Remove sources of heat or open flame. Provide adequate ventilation. Cleanup personnel to use self-contained respirator and protective clothing. Stop leakage if possible; remove leaking containers to safe area for discharge and allow to evaporate in an area remote from buildings and people.

DISPOSAL: Material can be reclaimed by distillation. Avoid discharge to environment when possible. Return scrap to supplier, if possible. Follow Federal, state, and local regulations.

EPA Hazardous Waste No.: U121; F001, F002

## SECTION 8. SPECIAL PROTECTION INFORMATION

Provide adequate mechanical ventilation to keep vapors below the TLV level. Supply ventilation for sumps and low-lying areas where the dense vapors of this material may collect. Local exhaust should be used where large amounts are released. Use approved self-contained or air-supplied breathing apparatus and lifelines for emergencies. Use chemical safety goggles and/or face shield to prevent liquid contact with eyes where splashing is possible. Wear neoprene or butyl gloves and clothing appropriate for the work situation to minimize skin contact with liquid.

Eyewash stations and safety showers should be readily accessible near areas of use.

Contact lenses may pose a special hazard: soft lenses may absorb and all lenses concentrate irritants.

Vaporization of excessive amounts can displace oxygen necessary for breathing and may cause suffocation when used in confined spaces or areas without ventilation.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

Store containers in a cool (below 125°F, 51.6°C), dry, well-ventilated area away from open flame and heat sources. Arc-producing equipment or other high-temperature equipment should not be used in a fluorinated hydrocarbon atmosphere. Protect containers from physical damage. High-density vapors may displace air and present an asphyxiation hazard. Concentrations well below the TLV level can damage space heaters when drawn into the combustion chamber. Heater should have independent air supply.
Prevent skin and eye contact with liquid. Avoid inhalation of vapors. Thermal decomposition products can form halogen acids that have very sharp stringent effects and can be detected by odor. Such odor is a hazard warning; when detected, immediately evacuate the area and ventilate.

Data Source(s) Code: 1-8,12,17,26,33,38,47, 82. CK



Approvals JC. Rocco

Indust. Hygiene/Safety

Medical Review

# Material Safety Data Sheet

From Genium's Reference Collection
Genium Publishing Corporation
1145 Catalyn Street
Schenectady, NY 12303-1836 USA
(518) 377-8855

GENIUM PUBLISHING CORP.

No. 382

VINYL CHLORIDE
(Revision A)
Issued: August 1978
Revised: August 1988

## SECTION 1. MATERIAL IDENTIFICATION 26

**Material Name:** VINYL CHLORIDE

**Description (Origin/Uses):** Widely used to make PVC resins and plastics; also used in organic synthesis.

**Other Designations:** VCM; Vinyl Chloride Monomer; Chloroethylene; Chloroethene; $C_2H_3Cl$; CAS No. 0075-01-4

NFPA

**Manufacturer:** Contact your supplier or distributor. Consult the latest edition of the *Chemicalweek Buyers' Guide* (Genium ref. 73) for a list of suppliers.

| HMIS | |
|---|---|
| H 2 | R 1 |
| F 4 | I 4 |
| R 1 | S 3 |
| PPG* | K 4 |
| *See sect. 8 | |

| SECTION 2. INGREDIENTS AND HAZARDS | % | EXPOSURE LIMITS |
|---|---|---|
| Vinyl Chloride, CAS No. 0075-01-4 | Ca 100 | **OSHA PEL**<br>8-Hr TWA: 1 ppm*<br><br>**ACGIH TLV, 1987-88**<br>TLV-TWA: 5 ppm, 10 mg/m³<br><br>**Toxicity Data****<br>Rat, Oral, $LD_{50}$: 500 mg/kg |

*The action level set by OSHA in 29 CFR 1910.1017 is 0.5 ppm. Exposures above this level are strictly regulated by extensive medical record keeping, reporting, surveillance, and other requirements. Consult 29 CFR 1910.1017 for details.

**See NIOSH, *RTECS* (No. KU9625000), for additional data with references to mutagenic, reproductive, and tumorigenic effects.

## SECTION 3. PHYSICAL DATA

**Boiling Point:** 61°F (16°C)
**Water Solubility (%):** Insoluble
**Molecular Weight:** 107 Grams/Mole
**Vapor Density (Air = 1):** 2.2

**Appearance and Odor:** A colorless gas; mild, sweet odor at high concentrations.

## SECTION 4. FIRE AND EXPLOSION DATA

| Flash Point and Method | Autoignition Temperature | Flammability Limits in Air | LOWER | UPPER |
|---|---|---|---|---|
| | | | | |
| -108.4°F (-78°C) | 882°F (472°C) | % by Volume | 3.6% | 33% |

**Extinguishing Media:** Vinyl chloride gas is a severe fire and explosion hazard; treat any fire involving it as an emergency. Try to shut off the flow of gas. Use a water spray to protect the personnel attempting this and to cool fire-exposed cylinders/containers of vinyl chloride.

**Unusual Fire or Explosion Hazards:** This heavier-than-air gas can flow along surfaces, reach distant sources of ignition, and flash back. Eliminate sources of ignition in the workplace, particularly in low-lying areas such as sumps, cellars, basement utility rooms, and underground piping systems.

**Special Fire-fighting Procedures:** Wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in the pressure-demand or positive-pressure mode.

## SECTION 5. REACTIVITY DATA

Vinyl chloride is stable in closed, airtight, pressurized containers at room temperature under normal storage and handling conditions. It can undergo hazardous polymerization if it is heated or reacted with a polymerization catalyst, or if the concentration/activity of the added inhibitor becomes too low.

**Chemical Incompatibilities:** This material is incompatible with copper, aluminum, and other polymerization catalysts or free radical initiators like hydroquinone.

**Conditions to Avoid:** Do not allow sources of ignition such as open flame, unprotected heaters, lighted tobacco products, electric sparks, or excessive heat in work areas. Avoid prolonged exposure to air, especially in the presence of certain contaminants, because dangerous levels of polyperoxides may accumulate. Avoid exposure to sunlight; if the proper catalytic conditions occur, the vinyl chloride monomer may react with itself and undergo an explosive polymerization reaction. Violent ruptures of containers of this gas can occur.

**Hazardous Products of Decomposition:** During fires, vinyl chloride may decompose into toxic gases such as hydrogen chloride, carbon monoxide, and phosgene.

## SECTION 6. HEALTH HAZARD INFORMATION

Vinyl chloride is listed as a carcinogen by the ACGIH, NTP, and IARC with sufficient epidemiological evidence from human studies.

**Summary of Risks:** Vinyl chloride depresses the central nervous system (CNS), causing effects that resemble mild alcohol intoxication; however, these effects can progress to narcosis, eventual collapse, and even death as the intensity and/or duration of the exposure continues. Thrombocytopenia (decrease in blood platelets) has been reported following exposures.

**Medical Conditions Aggravated by Long-Term Exposure:** Possible liver effects. **Target Organs:** Respiratory system, skin, eyes, kidneys, hematopoietic (blood) system, and musculoskeletal system. **Primary Entry:** Inhalation. **Acute Effects:** Headache, dizziness, lightheadedness, skin and eye irritation. **Chronic Effects:** Cancer, especially angiosarcoma of the liver.

**FIRST AID: Eyes.** Immediately flush eyes, including under the eyelids, gently but thoroughly with plenty of running water for at least 15 minutes. **Skin.** Skin contact with liquid vinyl chloride causes frostbite (cryogenic injury). Treat this accordingly. **Inhalation.** Remove the exposed person to fresh air; restore and/or support his or her breathing as needed. **Ingestion.** Unlikely.

**GET MEDICAL HELP (IN PLANT, PARAMEDIC, COMMUNITY) FOR ALL EXPOSURES. Seek prompt medical assistance for further treatment, observation, and support after first aid.**

## SECTION 7. SPILL, LEAK, AND DISPOSAL PROCEDURES

**Spill/Leak:** *Treat any vinyl chloride gas leak as an emergency.* Preplan emergency responses and make sure all personnel know about them. Notify safety personnel, evacuate all nonessential personnel, provide maximum explosion-proof ventilation, and eliminate all sources of ignition immediately. Make sure cleanup personnel have protection against contact with this material and inhalation of its vapor (see sect. 8). **Waste Disposal:** Contact your supplier or a licensed contractor for detailed recommendations for disposal. Follow Federal, state, and local regulations.

**OSHA Designations**

Air Contaminant (29 CFR 1910.1000 Subpart Z)

Vinyl chloride is specifically regulated by OSHA at 29 CFR 1910.1017 as a suspected carcinogenic agent.

**EPA Designations (40 CFR 302.4)**

RCRA Hazardous Waste, No. U043

CERCLA Hazardous Substance, Reportable Quantity: 1 lb (0.454 kg), per Clean Water Act (CWA), section 307 (a); Clean Air Act (CAA), section 112; and Resource Conservation and Recovery Act (RCRA), section 3001.

## SECTION 8. SPECIAL PROTECTION INFORMATION

**Goggles:** Always wear protective eyeglasses or chemical safety goggles. Follow OSHA eye- and face-protection regulations (29 CFR 1910.133). **Respirator:** Consult the *NIOSH Pocket Guide to Chemical Hazards* for general recommendations on respirators. Follow OSHA respirator regulations (29 CFR 1910.134). For emergency or nonroutine use (leaks or cleaning reactor vessels and storage tanks), wear an SCBA with a full facepiece operated in the pressure-demand or positive-pressure mode. **Warning:** Air-purifying respirators will *not* protect workers in oxygen-deficient atmospheres. **Other:** Wear impervious gloves; boots; aprons; head covers; and clean, impervious, body-covering clothing to prevent any possibility of skin contact with vinyl chloride. All clothing must be flame resistant. **Ventilation:** Install and operate general and local ventilation systems powerful enough to maintain airborne levels of vinyl chloride below the OSHA PEL standard cited in section 2. All ventilation systems must be of maximum explosion-proof design, e.g., nonsparking, electrically grounded and bonded. **Safety Stations:** Make eyewash stations, safety showers, and washing facilities available in areas of use and handling. **Contaminated Equipment:** Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them. Do *not* wear contact lenses in any work area. **Other:** Design all engineering systems to be explosion-proof in areas where vinyl chloride gas may occur. Pressure check all pipes and equipment used with this gas and make sure that all connections are leak tight. **Comments:** Practice good personal hygiene; always wash thoroughly after using this material. Avoid transferring it from your hands to your mouth while eating, drinking, or smoking. Do *not* eat, drink, or smoke in any work area.

## SECTION 9. SPECIAL PRECAUTIONS AND COMMENTS

**Storage/Segregation:** Store vinyl chloride in a cool, dry, well-ventilated area away from sources of ignition and incompatible chemicals. Outside or detached storage is recommended. Shade containers from radiant heat and direct sunlight. **Special Handling/Storage:** Vinyl chloride is shipped/stored as a pressurized gas in cylinders or tank cars. Protect these containers against physical damage and regularly inspect them for cracks, leaks, or faulty valves. Ground and bond all containers used in shipping/transferring operations. Store cylinders upright; secure them tightly; do not drag or slide them; move them in a carefully supervised manner with a suitable hand truck. Monitor the activity and concentration of the added inhibitor to the vinyl chloride product. Follow your supplier's recommendations concerning proper shelf life, rotation of inventory, and maintenance of purity. **Engineering Controls:** Make all engineering systems (ventilation, production, etc.) of maximum explosion-proof design. **Comments:** Perform all operations with vinyl chloride carefully to prevent accidental ignition. Do not smoke in any use or storage area. Maintain the valve protection cap in place until immediately before using vinyl chloride. Insert a check valve or trap into the transferral line to prevent a dangerous backflow into the original container. Use pressure-reducing regulators when connecting cylinders to lower-pressure piping systems. Obtain detailed handling, shipping, and storage information from your supplier. A trained chemist or safety specialist familiar with the physical and chemical properties of this material should be present during all work operations.

**Transportation Data (49 CFR 172.101-2)**

**DOT Shipping Name:** Vinyl Chloride
**DOT ID No.** UN1086
**DOT Label:** Flammable Gas
**DOT Hazard Class:** Flammable Gas
**IMO Label:** Flammable Gas
**IMO Class:** 2.1

**References:** 1, 2, 12, 73, 84-94.



Prepared by PJ Igoe, BS

Industrial Hygiene Review: DJ Wilson, CIH

Medical Review: MJ Hardies, MD

# Attachment D
# Baker Environmental, Inc.
# Safety Standard Operating Procedures

ATTACHMENT D

BAKER ENVIRONMENTAL, INC.
SAFETY STANDARD OPERATING PROCEDURES

TABLE OF CONTENTS

Baker Environmental, Inc.

# 1.0 - CONFINED SPACE ENTRY PROGRAM

## 1.1 INTRODUCTION

All confined space entries shall be performed in accordance with the following program based on the "Criteria Document for a Recommended Standard for Working in Confined Spaces," issued by NIOSH. A confined space refers to a space, which by design has limited openings for entry and exit; unfavorable natural ventilation which could contain or produce dangerous air contaminants; and which is not intended for continuous employee occupancy.

Confined spaces include, but are not limited to, storage tanks, compartments of ships, process vessels, pits, silos, degreasers, reaction vessels, boilers, ventilation and exhaust ducts, sewers, tunnels, underground utility vaults, and pipelines. If there is a question as to whether or not an area should be considered as a confined space, appropriate safety personnel should be consulted prior to entry.

## 1.2 HAZARD IDENTIFICATION

Identify and evaluate each hazard of the permit spaces. Hazardous substances should be identified through the use of Dräger tubes and/or direct reading instruments such as HNu or OVA meters. Oxygen and explosive levels will be monitored using a Lower Explosive Level/Oxygen ($LEL/O_2$) meter.

## 1.3 HAZARD CONTROL

Establish and implement the means, procedures, and practices by which the permit spaces can be entered safely. Ventilation and area cleaning should be considered in addition to personal protective equipment.

## 1.4 PERMIT SYSTEM

The Health and Safety Officer (HSO) or designee will complete the confined space entry permit, as attached. This form must be posted at the point of entry and is valid for eight consecutive hours. After eight hours, or sooner if there is reason to believe that conditions

may have changed, additional environmental testing and a new permit must be completed. Completed, expired permits must be returned to the HSO, or designee.

## 1.5 EMPLOYEE INFORMATION

Signs shall be posted near permit confined spaces to notify employees as to hazards that may be present and that only authorized personnel may enter.

## 1.6 EMPLOYEE TRAINING

All employees entering or directly involved in the confined space activities must complete a 40-hour health and safety training course in accordance with 29 CFR 1910.120. Additionally, site-specific training must be conducted regarding the hazards associated with each confined space and confirmed space entry procedures including the following subjects:

- Oxygen Deficiency
- Explosivity
- Toxics
- Ventilation
- Personal Protective Equipment/Procedures
- Respiratory Protection
- Initial Entry and Monitoring
- Emergency Procedures and Egress

## 1.7 EQUIPMENT

All equipment must be inspected and maintained to ensure the proper use of the equipment, necessary for safe entry. Respirators and emergency equipment, lanyard, harness, etc. must be thoroughly inspected prior to the confined space entry. Records of the inspection shall be kept in the project file. The equipment shall be adequately decontaminated following each entry.

## 1.8 RESCUE

Ensure that procedures and equipment necessary to rescue entrants from permit spaces are implemented and provided. The buddy system shall be used for all entries. The attached table provides a list of requirements with respect to each entry classification. The following items describe the three confined space entry classifications.

I CLASS A

- Immediate Danger to Life and Health (IDLH) condition exists
- Should only be entered under emergency conditions (Level A or B protection ensembles)
- Efforts should be made to reduce IDLH levels such as ventilation, cleaning, etc.
- IDLH conditions may include:
  - Oxygen levels below 19.5% or greater than 22%
  - LEL levels 20% or greater
  - Contaminant Concentration >PEL

II CLASS B

- Dangerous, but not IDLH conditions
- Levels of protection can range from C to A
- Range of conditions:
  - Oxygen from to 19.5% to 21.5%
  - LEL levels from 10% to 19%
  - Contaminant Concentration ≥ the PEL

III CLASS C

- Low Hazard Potential
- Requires no modification of work procedures but constant monitoring
- Range of conditions:
  - Oxygen levels from 19.5% to 22%
  - LEL levels less or equal to 10%
  - Contaminant Concentrations < the PEL

# CONFINED SPACE ENTRY

| ITEM | CLASS A | CLASS B | CLASS C |
|---|---|---|---|
| 1. Permit | X | X | X |
| 2. Atmospheric Testing | X | X | X |
| 3. Monitoring | X | O | O |
| 4. Medical Surveillance | X | X | O |
| 5. Training of Personnel | X | X | X |
| 6. Labeling and Posting | X | X | X |
| 7. Preparation<br>Isolate/Lockout/Tag | X | X | X |
| Purge and Ventilate | X | X | O |
| Cleaning Procedures | O | O | O |
| Requirements for Special Equipment/Tools | X | X | O |
| 8. Procedures<br>Initial Plan | X | X | X |
| Standby | X | X | O |
| Communication/Observation | X | X | X |
| Rescue | X | X | X |
| Work | X | X | X |
| 9. Safety Requirement and Clothing<br>Head Protection | O | O | O |
| Hearing Protection | O | O | O |
| Hand Protection | X | O | O |
| Foot Protection | X | O | O |
| Body Protection | X | O | O |
| Respiratory Protection | X | X | O |
| Safety Belts | X | X | X |
| Life Lines, Harness | X | X | X |
| 10. Rescue Equipment | X | X | X |
| 11. Recordkeeping/Exposure | X | X | X |

X - Indicates requirements
O - Indicates determination by the qualified individual

ALL COPIES OF PERMIT
WILL REMAIN AT JOB SITE
*UNTIL JOB IS COMPELTED*

☐ CONFINED SPACE ENTRY PERMIT
☐ HAZARDOUS AREA ENTRY PERMIT

LOCATION and DESCRIPTION
of Confined Space _____ Date _____

PURPOSE of Entry _____ Time _____ M

JOB/SITE _____ Expiration _____ M

PERSON in Charge of Work _____

| SAFETY REQUIREMENTS | Yes | No | | Yes | No |
|---|---|---|---|---|---|
| Lock Out - De-Energize | | | Escape Harness | | |
| Lines Broken - Capped or Blanked | | | Tripod Emergency Escape Unit | | |
| Purge - Flush and Vent | | | Lifelines | | |
| Ventilation | | | Fire Extinquishers | | |
| Secure Area | | | Lighting | | |
| SAR or SCBA | | | Protective Clothing | | |
| Resuscitator - Inhalator | | | Respirator (half mask or full face) | | |

| TEST(S) TO BE TAKEN<br>Valid for One 8-Hour Entry | Yes | No | CONCENTRATION | INSTRUMENT USED<br>AND DATE CALIBRATED |
|---|---|---|---|---|
| % of Oxygen | | | | |
| % of L.E.L.* | | | | |
| Carbon Monoxide | | | | |
| Aromatic Hydrocarbon | | | | |
| Hydrocyanic Acid | | | | |
| Hydrogen Sulfide | | | | |
| Sulfur Dioxide | | | | |
| Ammonia | | | | |
| Other: | | | | |
| Other: | | | | |

*L.E.L. = Lower Explosion Level

*Permit Issued By: _____ _____
print Name Signature

Note: Continuous/periodic tests shall be established before beginning job. Any questions pertaining to test requirements contact the On-Site Health and Safety Officer.

| SAFETY STANDBY PERSON(S) | Name | Check No. |
|---|---|---|
| | | |
| | | |

AMBULANCE: _____ FIRE: _____

*Health and Safety Officer or Qualified Designee

Baker Environmental, Inc

# 2.0 - RESPIRATORY PROTECTION PROGRAM

## 2.1 INTRODUCTION

In accordance with OSHA requirements (29 CFR 1910.134), this document represents Baker Environmental, Inc.'s (Baker's) program governing the selection and use of respiratory protection for its employees. It is Baker's policy to provide its employees with the proper protective equipment, training, and medical surveillance necessary to protect individuals from any potential hazards which may be present during the tasks performed throughout the course of each individual's employment. This program specifically describes the procedures which have been established and implemented for the use of respiratory protection equipment. The effectiveness of this program shall be reevaluated on an annual basis and appropriate changes shall be made if deemed necessary.

## 2.2 EMPLOYER RESPONSIBILITY

Baker shall provide its employees the respiratory protection equipment which is appropriate and suitable for the purpose intended, when such equipment is necessary to protect the health of the employee.

## 2.3 EMPLOYEE RESPONSIBILITY

The employee shall use the respiratory protection provided in accordance with instructions and training received, and shall report any malfunction of the equipment to a responsible person. The employee shall not wear contact lenses in atmospheres where respiratory protection is required. Corrective lens inserts will be provided, at Baker's expense, for employees who require corrective lenses.

## 2.4 HAZARD ASSESSMENT

The key elements of a respiratory protection program must start with an assessment of the inhalation and ingestion hazards present in the work area. Because Baker's services involve a variety of environmental and industrial hygiene studies, it is not practical to identify all

possible hazards to which all employees could be exposed within the scope of this document. Therefore, it is essential that a task specific assessment be conducted prior to the initiation of any activities on a given project. This task specific assessment may be part of the site-specific Health and Safety Plan.

After a task-specific assessment is completed and it is determined that airborne exposure concentrations exceed or may exceed the recommended limits, engineering and administrative controls should be implemented, whenever feasible.

If the exposure cannot be reduced, or it is not feasible to reduce the airborne exposure below the recommended limits, respirators will be selected by the Site Health and Safety Officer on the basis of:

- Toxicity
- Maximum Expected Concentration
- Oxygen Levels
- Warning properties of the substance(s) involved
- Sorbent Limitations
- Facepiece Fit
- Mobility Requirements
- Type of Use (routine, escape, or emergency entry)
- Possibility of Ingestion of Toxic Materials
- Respirator Attributes

## 2.5 TRAINING

Each respirator wearer shall be given training, by a qualified individual, which will include explanations and discussions of:

- Opportunity to wear respiratory protection in an uncontaminated environment.
- Respirator Kit Testing (qualitative)
- The respiratory hazard(s) and what may occur if the respirator is not used properly.
- The reasons for selecting a particular type of respirator.
- The function, capabilities, and limitations of the selected respirator.
- The method of donning the respirator and checking its fit and operation.
- The proper wearing of the respirator.

- Respirator maintenance, repair, and cleaning.
- Recognizing and handling emergency situations.

Respirator training will be conducted on an annual basis, at a minimum. Records of the training and fit-testing will be maintained for a minimum of 30 years following termination of employment for each employee.

## 2.6 TYPES OF RESPIRATORS

Baker provides employees with the North Brand half-face (Model 7700) and full-face (Model 7600) air purifying respirators, positive pressure 30-minute Self-Contained Breathing Apparatus (SCBAs) (Model 800), positive pressure supplied airline respirators, with 5-minute escape air cylinders (Model 85500). Only respiratory equipment certified by the appropriate approval agencies (e.g., NIOSH, MSHA) according to Title 30, Part II of the Code of Federal Regulations, will be distributed to Baker employees. As an alternate air purifying respirator, Baker will also keep, on-hand, the MSA ultra twin full-face respirator. All Baker employees who regularly perform tasks requiring respiratory protection will be issued their own half-face or full-face respirator, provided the employee can achieve a proper fit and is medically capable of wearing the equipment.

Because 30-minute SCBAs, positive pressure supplied airline respirators, and 5-minute escape air cylinders are used less frequently, this equipment will be distributed on an as-needed basis.

## 2.7 AIR QUALITY

Compressed and liquid air used for respiration shall be of high purity. Breathing air shall meet at least the requirements of the specification for Grade D breathing air as described in Compressed Gas Association Commodity Specification G-7.1-1966. Breathing air may be supplied to respirators from cylinders or air compressors. Oxygen must never be used with air line respirators.

Air cylinders shall be tested and maintained as prescribed in the Shipping Container Specification Regulations of the Department of Transportation (49 CFR Part 178). Air line couplings shall be incompatible with outlets for other gas systems to prevent inadvertent servicing of air line respirators with nonrespirable gases or oxygen.

Breathing gas containers shall be marked in accordance with American National Standard Method of marking Portable Compressed Gas Containers to Identify the Material Contained, Z48.1-1954; Federal Specification BB-A-1034a, June 21, 1968, Air, Compressed for Breathing Purposes; or Interim Federal Specification GG-B-00675b, April 27, 1965, Breathing Apparatus, Self-Contained.

## 2.8 CLEANING AND MAINTENANCE

Respirator maintenance will be performed by each trained individual on a regular basis. The maintenance shall be carried out on a schedule which ensures that each respirator wearer is provided with a respirator that is clean and in good operating condition.

Respiratory equipment that is used on an as-needed basis shall be maintained by qualified personnel. This equipment shall be cleaned/sanitized, then rinsed and air-dried, after each use. Inspections shall be conducted before and after each use.

Respiratory equipment that has been issued to an employee shall be cleaned/sanitized then rinsed and air-dried by the wearer on a schedule (specified by OSHA in 29 CFR 1910.134) which ensures that it will be maintained in clean and good operating condition. Inspections shall be conducted on a regular basis during usage and prior to each project requiring the potential usage of the equipment.

All respirators shall be stored in a plastic bag within a cool/dry location, in a manner that will protect them against dust, sunlight, heat, extreme cold, excessive moisture, or damaging chemicals. They shall be stored to prevent distortion of rubber or other elastomer parts.

Parts replacement and repairs shall be performed only by appropriate personnel. Equipment requiring repairs shall be reported to appropriate Baker personnel. Examples of inspection forms are included at the end of this text.

## 2.9 FIT-TESTING

Each respirator wearer shall be provided with a respirator that can properly form a secure face to mask seal. Each wearer shall be fit-tested prior to issuance of the respirator using either an irritant smoke or odorous vapor, or other suitable test agent. Retesting shall be performed, at

a minimum, on an annual basis or if a different model respirator, other than the model he/she was previously fit-tested for, is to be used by the wearer. Respirators fit-tested qualitatively will be assigned a protection factor of 10 (APF = 10).

Facial hair, which interferes with the normally effective face to mask seal, is prohibited. Each respirator wearer shall be required to check the seal of the respirator by appropriate means prior to entering a harmful atmosphere.

## 2.10 MEDICAL SURVEILLANCE

Personnel who are or may be assigned to tasks requiring use of respirators shall participate in a medical surveillance program on an annual basis. The medical surveillance program shall include, but may not be limited to, a physical and a pulmonary function test conducted by the company's physician and at the expense of the company. Test parameters included in Baker's medical surveillance program is included as Attachment A in each site-specific Health and Safety Plan.

## 2.11 LIMITATIONS

Wearing any respirator, alone or in conjunction with other types of protective equipment, will impose some physiological stress on the wearer. Therefore, selection of respiratory protective devices will be based on the breathing resistance, weight of the respirator, the type and amount of protection needed as well as the individual's tolerance of the given device. Additional concerns regarding the limitations of different types of PPE and the monitoring requirements for heat stress/strain will be addressed in the Health and Safety Plan under the Heat Stress section.

# FULL-FACE AND HALF-FACE RESPIRATOR INSPECTION FORM

| Inspection Date | Date Last Used | FACE PIECE | | | | | HEADSTRAPS OR HEADBANDS | | RESPIRATOR INTERIOR | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Clean and Sanitized | No Cracks, Tears, or Holes | Proper Shape and Flexibility | Air Purifying Element Holders Operate Correctly | Proper Storage Free From Heat, Dirt, Sunlight, etc. | No Signs of Wear or Tears | Buckles Function Properly | No Foreign Material Under Valve Seat | No Cracks or Tears in Valves or Valve Bodies | Valve Covers and Bodies in Good Condition and Installed Correctly |
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## SCBA AND SUPPLIED AIRLINE RESPIRATOR INSPECTION FORM BEFORE AND AFTER EACH USE

| Date Used | Cylinder OK | Cylinder Changed | Facepiece and Hoses | Entire Apparatus OK | Cleaned and Sanitized | Connections OK | Remarks | Inspected By | Date Inspected |
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# 3.0 - CARE AND CLEANING OF PERSONAL PROTECTIVE EQUIPMENT

## 3.1 INTRODUCTION

The following procedures cover the care and cleaning of Levels D, C, and B personal protective equipment. Note: These are general procedures that apply to most situations and are not all inclusive. Procedures are subject to change at the direction of the on-site HSO.

## 3.2 EQUIPMENT CARE

### 3.2.1 Chemical Resistant Suit (Levels C and B)

- Before donning, inspect suit for holes or tears; check to see that zippers are operable; and look for signs of suit degradation.

- When wearing, avoid contact with contaminated material where possible; be aware of sharp objects that can tear suit; periodically look over suit to check for major rips or tears.

- While decontaminating, remove gross excess of material from suit; remove suit so that material does not contact inner suit; place clothing in properly labeled disposal containers.

### 3.2.2 Inner/Outer Gloves (Levels D through B)

- Look for rips, tears, or degradation of material. Replace as necessary or at the direction of the on-site HSO.

### 3.2.3 Chemically Resistant Boots (Levels C and B)

Non-disposable boots are to be examined on a daily basis before and after use. Disposable boots should be examined prior to donning and while in use. Dispose of according to site procedures.

### 3.2.4 Hard Hats (Levels D through B)

Should be visually inspected before donning for fit, cracks, and overall condition.

### 3.2.5 Respirators (Levels C and B)

Procedures for care of respiratory protective equipment are covered in Attachment D - Baker SOPs.

## 3.3 EQUIPMENT CLEANING

General procedures for cleaning of equipment are listed below. Site-specific concerns will be addressed by the on-site HSO prior to start-up. Cleaning of respiratory equipment is covered under Attachment D - Baker SOPs.

### 3.3.1 Gross Physical Removal

Large amounts of contaminated soil is scraped off with a tongue depressor, or wiped off using a disposable wipe.

### 3.3.2 Physical/Chemical Removal

The residual contamination will be scrubbed with a soft-bristled, long-handled brush using a detergent solution.

### 3.3.3 Rinsing/Dilution

The detergent solution and residual contaminants will be rinsed with tap water using a pressurized sprayer.

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# 4.0 - SANITATION/SITE PRECAUTIONS

## 4.1 SANITATION

- A supply of clearly marked potable water, tightly closed, and equipped with a tap.
- Single service cups/disposal for used cups.
- Outlets for non-potable water, clearly marked, for fire fighting or other purposes. Cross-contamination of the potable supply shall be prevented.
- One toilet facility which is either chemical, recirculating, combustion, or flush, depending on local code requirements.
- A place for food handling facility must meet all applicable laws, otherwise this activity may be restricted by on site management. In the event, suitable alternatives to such facilities will be provided (i.e., nearby restaurants, food wagons, etc.).
- Clean wash water will be available in the decontamination zone.

## 4.2 SITE PRECAUTIONS

- Eating, drinking, chewing gum or tobacco, smoking, or any practice that increases the probability of hand-to-mouth transfer and ingestion of material, is prohibited in any area designated as contaminated.
- No smoking will be allowed on-site.
- Hands and face must be thoroughly washed upon leaving the work area.
- Whenever decontamination procedures for outer garments are in effect, the entire body should be thoroughly washed as soon as possible after the protective garment is removed.

- No work garments are to be worn off site.

- Contact lenses are not permitted to be worn on site.

- No facial hair which interferes with a satisfactory fit of the mask-to-face seal, is allowed on personnel required to wear respirators.

- Contact with contaminated or suspected contaminated surfaces should be avoided. Wherever possible, do not walk through puddles, leachate, discolored surfaces, kneel on ground, lean, sit or place equipment on drums/containers.

- Medicine and alcohol can potentiate the effects from exposure to toxic chemicals. Prescribed drugs should not be taken by personnel where the potential for absorption, inhalation, or ingestion of toxic substances exist unless specifically approved by a qualified physician. Alcoholic beverage intake should be minimized or avoided during after-hour operations.

- Alcoholic beverages are prohibited on site.

- Personal radios, TVs, and tape players are prohibited on site.

- Firearms are prohibited on site.

- All personnel will observe any posted sign, warning, fence, or barrier posted around contaminated areas.